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HENRI POINCARÉ AS A MATHEMATICAL PHYSICIST[1]

WHEN I was asked by the secretary to contribute a paper of general interest before this section I was overwhelmed with the sense of my inability to do so, but when he suggested that I should take as a subject the work of Henri Poincaré as a mathematical physicist, I consented, because, however slight might be my capability, the subject was a most congenial one. The great Frenchman whose untimely death at the age of 58 the whole scientific world deplores was a man of extraordinary versatility, while his productiveness is measured by the fact that the total number of separate contributions from his pen reaches nearly the sum of a thousand. France has always known how to honor her great men, even if she does not understand them, and the impression produced by the death of Poincaré on the whole country was profound. The news was communicated to me in London at the celebration of the Royal Society by his friend and distinguished colleague, Émile Picard, who in a voice choked with emotion pronounced the words, "Poincaré est mort!"

While there can be no doubt that the greatest work of Poincaré consisted in his work in pure analysis, we must not forget that for ten years he filled the chair of mathematical physics of the Faculté des Sciences. During this time he touched every conceivable part of the subject and it may be truly said that he touched nothing that he did not adorn. Fourteen volumes

[1] Read before Section A of the American Association for the Advancement of Science, December 31, 1912.

of published lectures attest his skill as a teacher, the names of which I will not take your time to rehearse, merely remarking that in addition to the usual treatments of electricity, optics, the conduction of heat, thermodynamics, capillarity, elasticity and hydrodynamics there are several volumes on the modern subjects of electrical oscillations and the interrelations of electricity and optics.

The work of the mathematical physicist is of two sorts, according as the emphasis is laid on the word physics or on the word mathematical. In the latter case the investigator concentrates his attention upon the attempt to demonstrate that certain problems have solutions, furnishing so-called existence theorems. In the former the attempt is made to find the solutions, assuming that they exist, in a form suitable for numerical computation. Poincaré did both, and, although capable of the highest flights into abstract mathematics, was by no means insensible to the needs of the practical man, meaning by that not only the physicist, but even the telegraph engineer. This is attested by the number of articles that he wrote on the theory of telegraphy, both with and without wires, as well as by the courses of lectures that he gave at the higher professional school of posts and telegraphs. It is certainly a very rare thing for a pure mathematician of the highest ability to write an article on the theory of the telephone receiver, yet this was done by Poincaré, while in a paper on the propagation of current in the variable period on a line furnished with a receiver he attacked an almost untouched field of very great mathematical importance in the theory of differential equations.

What is particularly striking in all of Poincaré's writings is not so much the clearness of exposition or the elegance of arrangement, for his lectures possess many of the faults of lectures published by students and his short articles are often extremely difficult reading, but rather the remarkable directness with which he proceeds to his results and the extraordinary command of every resource of pure mathematics, particularly of Cauchy's theory of the functions of a complex variable. I know of but one other author whose resources in function-theory seem to be at all comparable with those of Poincaré, I mean Professor Sommerfeld, who seems to be able to communicate his powers in that line to his students. The heart of mathematical physics is, without doubt, composed of partial differential equations, and in this subject Poincaré was, of course, a master. It is in connection with the definite integrals appearing in their solutions that there is great opportunity for the application of function-theory. The great art in mathematical physics is that of making approximations and it is here that Poincaré was particularly strong. It is frequently not so difficult to obtain the solution of the differential equation as to interpret its physical meaning. In this matter Poincaré reminds us of his great countryman Cauchy.

I shall not attempt to make an analysis of the articles of Poincaré, many of which I have great difficulty in following and many of which could be far better treated by others here present. I shall merely undertake to give a slight idea of the contents of those which have particularly impressed me. I presume his contributions of most far-reaching importance from a mathematical point of view are his articles on the equations of mathematical physics, of which he wrote three. This is a subject which has received an enormous amount of attention during the last twenty-five years and it may be undoubtedly said that in

this work Poincaré's contributions were fundamental. His first article "Sur les Equations aux Dérivées Partielles de la Physique Mathématique" appeared in the *American Journal of Mathematics* in 1890. The equations of mathematical physics are all very similar and may be practically all reduced to three or four. Of these the equation of Laplace,

$$\frac{\delta^2 V}{\delta x^2} + \frac{\delta^2 V}{\delta y^2} + \frac{\delta^2 V}{\delta z^2} = \Delta V = 0,$$

is the most important. The so-called boundary problem of finding a solution of Laplace's equation, valid for a certain region of space, that shall take prescribed values at the surface bounding this space is known as Dirichlet's problem. Of this the problem of the distribution of electricity on the surface of a conductor is a particular case, the function given on the surface reducing to a constant.

The latter example is a case of the outside problem, where in addition we have the condition that the desired function must vanish at infinity. The demonstration of the existence of such a function given by Riemann and depending upon the application of the calculus of variations to the definite integral

$$\int\int\int \left[\left(\frac{\delta V}{\delta x}\right)^2 + \left(\frac{\delta V}{\delta y}\right)^2 + \left(\frac{\delta V}{\delta z}\right)^2\right] dxdydz$$

is lacking in rigor and the attempt to replace it has engaged the attention of some of the greatest mathematicians. In the present paper Poincaré gives a new method of great universality for proving the so-called Dirichlet principle. It depends upon the fact that the boundary problem can be exactly solved for the sphere and also upon the theorem discovered by Green that a potential function due to attracting masses lying within a closed surface may be exactly imitated by placing the masses in a surface distribution on the surface of the sphere. This Poincaré calls the *balayage* of the sphere, the masses being swept out of the interior and deposited on the surface. For any surface to be treated the space within is filled up by an infinite number of spheres such that any point within the given surface lies in at least one of them, and these spheres are swept in a certain order so that the process is a convergent one. The principle of Dirichlet is thus established, but a practical method of finding the solution is not given. The other equation considered in this paper is Fourier's equation for the conduction of heat,

$$\frac{\delta V}{\delta t} = a^2 \Delta V.$$

In this case the boundary condition is not as simple as in Dirichlet's problem, but we have at the surface,

$$\frac{\delta V}{\delta n} + hV = 0,$$

where h is called the emissivity of the body. In this case it is demonstrated by the aid of the calculus of variations that the problem is possible, the demonstration being that of the existence of an infinite series of functions U_n satisfying the conditions that on the surface of the body

$$\frac{\delta U_n}{\delta n} + hU_n = 0$$

and in its interior

$$\Delta U_n + k_n U = 0,$$

where the numbers $k_1, k_2 \cdots k_n$ are positive constants such that

$$k_1 < k_2 < k_3 \cdots .$$

Physically these functions have the property that if the temperature of the body at a given instant is distributed according to any one of them then this distribution will remain unchanged during all subsequent time, merely dying away at an exponential rate. It is interesting to notice that in the last part of this paper Poincaré compares his process to that used by

Fourier in deducing his equation; namely, by supposing the body to be composed of a large number of small bodies each radiating heat to all the others according to the law that the amount of heat radiated in a given time is proportional to the difference of temperature of the two bodies. Thus a system of ordinary differential equations is arrived at,

$$\frac{dV_i}{dt} + \sum_{k=1}^{k=n} C_{ik}(V_i - V_k) + C_i V_i = 0, \quad i = 1, 2 \cdots n,$$

which is readily solved by putting

$$V_i = U_i e^{-\lambda t},$$

in which case the differential equations become algebraic linear equations for the quantities U_i,

$$\lambda U_i = \sum_k C_{ik}(U_i - U_k) + C_i U_i.$$

In order to solve them it is necessary that the determinant

$$\Delta = \begin{vmatrix} C_1 - \lambda, & -C_{12}, & -C_{13}, & \cdots \\ -C_{12}, & C_2 - \lambda, & -C_{23}, & \cdots \\ \cdots & \cdots & \cdots & \cdots \end{vmatrix}$$

should vanish. But we get the same equations if we consider the quadratic form

$$\Phi \equiv \Sigma C_{ik}(V_i - V_k)^2 + \Sigma C_i V_i^2,$$

which being equated to a constant represents an ellipsoid in n-dimensional space. The equations for the axes are our linear equations. The axes of this ellipsoid being all real, all the roots of the determinant Δ are real. The form may then be decomposed into a sum of squares.

$$\Phi = \lambda_1 \phi_1^2 + \lambda_2 \phi_2^2 \cdots, \text{ where}$$
$$\phi_p = U_{p1} U_1 + U_{p2} U_2 \cdots.$$

Upon the properties of this quadratic form depends the whole theory. When the number of particles becomes infinite the system of ordinary differential equations leads in the limit to Fourier's partial differential equation, and the theorems which will arise if the passage to the limit is justified lead to Poincaré's deduction. It is to be noticed that this principle had been used before by Lord Rayleigh in connection with the theory of vibrations and the possibility of passing to the limit postulated by him is now known as Rayleigh's principle. More interesting still is the fact that to-day this process used by Rayleigh and Poincaré has become in the hands of Fredholm and Hilbert a rigorous method, that of integral equations, which is at present occupying a large part of the attention of the mathematical world.

In his second paper on the same subject published in 1894 in the *Rendiconti del Circolo Mathematico di Palermo,* Poincaré passes to the consideration of the more general equation

$$\Delta u + \xi u + f = 0,$$

where ξ is a constant and f a given space-function. This equation includes not only Fourier's equation but the equation of waves

$$\frac{\delta^2 \phi}{\delta t^2} = a^2 \Delta \phi + g$$

if we put

$$\phi = e^{int} u, \quad \xi = \frac{n^2}{a^2}.$$

Regions in which f is not zero are called sources of heat or sound. Poincaré proceeds in this equation to develop u according to powers of ξ, as had been done by Schwarz, thus obtaining a solution by successive approximations which he proves to be convergent. He also proves the fundamental property that a solution of the equation is a meromorphic function of the parameter ξ having an infinite number of simple poles, that is to say,

$$U = \Sigma \frac{\alpha_i U_i}{\xi - k_i} \quad \text{where} \quad \Delta U_i + k_i U_i = 0.$$

This theorem is also fundamental in the theory of integral equations. To speak in the language of sound Poincaré demonstrates the existence of an infinite number of natural vibrations for the air in a cavity surrounded by the given surface, the characteristic numbers k_i or values of the poles

of the solution giving us their periods, and the nature of the function U showing the phenomenon of resonance, that is to say, the vibration becoming infinite when the impressed force has the period of one of the natural vibrations. The method of Poincaré leads directly to Schmidt's solution of the integral equation.

In a third paper published in the *Acta Mathematica* in 1897 Poincaré deals with what he calls Neumann's problem, which he defines as follows: To find a potential of a double layer whose limiting values inside and outside the surface are denoted by V and V', and which satisfies the equation at the surface,

$$V - V' = \lambda(V + V') + 2\Phi,$$

where λ is a parameter. If $\lambda = -1$ this reduces to the interior Dirichlet's problem $V = \Phi$ and if $\lambda = 1$ to the exterior problem $V' = -\Phi$. By means of a development in powers of the parameter λ a solution is obtained by successive approximations which is proved to converge. One of the most important results of this paper is the demonstration of the existence of a series of what he calls fundamental functions which have the property of being potentials of simple layers, and

$$\frac{\delta\Phi_i}{\delta u} = -\lambda_i \frac{\delta\Phi'}{\delta n}$$

in terms of which he deems it probable that any function on the surface may be developed, so that when these functions are known Dirichlet's problem may be solved. These reduce for the sphere to spherical harmonics and for the ellipsoid to Lamé's functions, and they are the characteristic functions belonging to integral equations.

Let us now turn to a different field. In 1893 attention was called by Poincaré to an equation which has become famous, called by him the equation of telegraphists. This equation

$$a\frac{\delta^2 u}{\delta t^2} + 2b\frac{\delta u}{\delta t} + cu = \frac{\delta^2 u}{\delta n^2}$$

had been introduced before by Kirchhoff and Heaviside, but its physical interpretation had not been emphasized. If the first term is lacking it reduces to Fourier's equation and it had been shown by Sir William Thomson in 1855 that signals were propagated through a submarine cable in accordance with it. If the second and third terms are absent the equation reduces to the equation of sound in one dimension and shows the propagation of waves unchanged in form with a constant velocity. The equation of telegraphists may then be expected to combine the properties of transmission in waves and heat transmission with an infinite velocity. The first term arises from the consideration of the self-induction of the line neglected by Thomson and the second term from the resistance which can generally not be neglected. By the simple method of the assumption that u can be represented as a Fourier's integral, after taking out an exponential factor, so that

$$\frac{\delta^2 U}{\delta t^2} = \frac{\delta^2 U}{\delta x^2} + U, \quad U = \int_{-\infty}^{\infty} \theta(q) e^{iqx} dq,$$

Poincaré obtains the solution

$$U = \int_{-\infty}^{\infty} e^{iqx} \left[\theta \cos t\sqrt{q^2 - 1} + \theta_1 \frac{\sin t\sqrt{q^2 - 1}}{\sqrt{q^2 - 1}}\right] dq,$$

which he shows by an application of the theory of functions to depend upon a Bessel function. The remarkable physical result is that while the disturbance, like the sound wave, is propagated with a finite velocity, after it has passed over a given point it leaves a residue or trail which gradually dies away like heat. In a later paper he discussed the effect on the telegraphist's equation of terminal conditions of a complicated sort necessitated by the employment of receiving apparatus.

Probably the favorite subject in mathe-

matical physics treated by Poincaré was that of electrical waves and oscillations. The reason for this is not far to seek. Not only are the equations of Maxwell's theory, complicated though they seem to be and involving a large number of vectors, capable of reduction to one of the forms already mentioned, but their solution calls for great knowledge of differential equations and even in the last few years in the hands of Poincaré permits of being treated by integral equations. Besides this the applications to the subject of wireless telegraphy are of great practical importance as well as theoretical interest. If we write Maxwell's equations in the simplest case,

$$\alpha = \frac{\delta H}{\delta y} - \frac{\delta G}{\delta z},$$

$$\cdots\cdots\cdots\cdots$$

$$4\pi f = -\frac{\delta F}{\delta t} - \frac{\delta \psi}{\delta n}, \qquad \frac{\delta f}{\delta x} + \frac{\delta s}{\delta y} + \frac{\delta k}{\delta z} = \rho,$$

$$\cdots\cdots\cdots\cdots \qquad \frac{\delta \alpha}{\delta x} + \frac{\delta \beta}{\delta y} + \frac{\delta \gamma}{\delta z} = 0,$$

$$4\pi\left(u + \frac{\delta f}{\delta t}\right) = \frac{\delta \gamma}{\delta y} - \frac{\delta \beta}{\delta z},$$

$$\cdots\cdots\cdots\cdots$$

where (α, β, γ) denotes the magnetic field, 4π $(f, g, h,)$ the electric field, u, v, w the conduction current, ρ the electric density, Ψ the electric scalar potential, (F, G, H) the vector-potential, where the vector-potential is defined by the differential equations

$$\alpha = \frac{\delta H}{\delta y} - \frac{\delta G}{\delta z}, \quad \cdots$$

there is still something indeterminate in this vector. Maxwell assumes

$$\frac{\delta F}{\delta x} + \frac{\delta G}{\delta y} + \frac{\delta H}{\delta z} = 0,$$

which does not lend itself to simplicity, but if instead we put, as was later done by Lorentz,

$$\frac{\delta F}{\delta x} + \frac{\delta G}{\delta y} + \frac{\delta H}{\delta z} + \frac{\delta \psi}{\delta t} = 0,$$

we get a great simplification. It is notable that this was done by Poincaré in 1893 in his lectures on electrical oscillations, evidently quite independently of Lorentz. Our equation for the vector-potential then reduces to the form

$$\frac{\delta^2 F}{\delta t^2} - \Delta F = 4\pi u,$$

which shows that if there is no current anywhere the vector-potential is propagated in waves. The scalar potential also satisfies the equation

$$\frac{\delta^2 \psi}{\delta t^2} - \Delta \psi = 4\pi\rho.$$

It was shown by Lorentz in 1892 and independently in the same year by Beltrami, that this equation, which, in case the first term vanishes, reduces to that of Poisson, is satisfied by a potential function

$$\psi = \iiint \frac{\rho' d\tau}{r},$$

in which, however, ρ' represents the value of ρ not at the instant in question but at an instant precedent by the time required to come from the point of integration with the wave-velocity. Such a potential is now known as a retarded potential and I may be allowed for a moment to digress upon the interesting history of this Lorentz-Beltrami equation. Its properties with those of the retarded potential are given by Poincaré in his lectures in 1893, evidently quite independently of Lorentz. It turns out, however, that the properties of the equation are given in Lord Rayleigh's "Theory of Sound," appearing in 1877. This, however, is not its first appearance, for we find the same equation in a paper by L. Lorenz, of Copenhagen, in 1869, on elasticity. More remarkable yet in a paper presented by Riemann to the Royal Society of Göttingen in 1858, but published only in 1867 after Riemann's death, we find the same identical equation for the electric potential although deduced from considerations which are now untenable. It is curious to remark that although this equation is mentioned by Maxwell in the last chapter

of his great work he does not commit himself as to its conclusions, but states that Clausius has shown that the hypothesis that the potential is propagated like light does not lead to the known laws of electrodynamics. Curiously enough, to-day this is exactly what we do believe, and it is interesting to know that such a result was vainly sought for by Gauss.

It is easy to conceive, the equations of electrical propagation being so similar to those of the propagation of sound waves, how the question of fundamental functions arises in connection with electrical oscillations emitted by a conductor of given form. The only case of anything except a linear conductor that has been completely treated is that of a sphere and of this a treatment was given in the same lectures in 1893 by Poincaré. One of the most important questions in wireless telegraphy has been during the last ten years and still is the explanation of the possibility of sending Hertzian waves across the Atlantic, a distance of perhaps one tenth of the way around the earth. The question of diffraction has always been an attractive one and in the case of electric waves makes great demands upon the powers of the mathematician. After a number of articles on the subject Poincaré in 1909 applies to it the method of integral equations, which he continues in a lecture on the Wolfskehl foundation at Göttingen, and later in a tremendous paper in the *Palermo Rendiconti.*

The development of Maxwell's electromagnetic theory that has taken place in the last twenty-five years has led to a theory that has attracted the greatest interest among mathematical physicists and has, in fact, become in certain parts of the world no less than a mania. I refer to the so-called principle of relativity, a name which was given to it first, if I am not mistaken, by Poincaré. This principle is no less than a fundamental relation between time and space, intended to explain the impossibility of determining experimentally whether a system, say the earth, is in motion or not. In an elaborate paper published in 1905 in the *Palermo Rendiconti* entitled, "Sur la dynamique de l'électron," he defines the principle of relativity by means of what he calls the Lorentz transformation. If the coordinates and the time receive the following linear transformation,

$$x' = kl(x + \epsilon t), \quad t' = kl(t + \epsilon x), \quad y' = ly,$$
$$z' = lz, \quad k = \frac{1}{\sqrt{1 - \epsilon^2}},$$

the function $x^2 + y^2 + z^2 - t_1^2$ and the equations of electric propagation will remain invariant. From this follows the impossibility of determining absolute motion. Poincaré then submits the Lorentz transformation, which he shows belongs to a group, to an examination with regard to the principle of least action, which he shows holds for the principle of relativity. He further shows that by the aid of certain hypotheses gravitation can be accounted for and shown to be propagated with the velocity of light. This is a subject which is now very much in the air, but it must be said that various writers arrive at conflicting results.

From what I have said, it will have been seen that Poincaré was exceedingly up-to-date and at once made the newest speculations and theories his own. As the final example of this may be named a theory which has created nearly as great a shock as that of relativity. I mean the theory of light *quanta* introduced by Planck to account for the laws of radiation from a hot body. In order to apply the laws of probability to electric resonators Planck had felt obliged to introduce the hypothesis that energy is emitted by resonators not in continuous amounts but in amounts depending upon certain multiples of a definite quantity

known as the quantum. In one of his very last papers published in January, 1912, in the *Journal de Physique*, Poincaré submits the theory of quanta to a searching examination and as a conclusion announces that it is impossible to arrive at Planck's law except under the assumption that resonators can acquire or lose energy only in discontinuous amounts. If this is true we have an extraordinary departure from received ideas and it will be necessary to suppose that natural phenomena do not obey differential equations.

Enough has been said to show the extraordinary variety of the subjects treated by this commanding intellect in the subject of mathematical physics alone. In repeating what I stated at the outset that the striking quality displayed by Poincaré is his extraordinary skill in analysis, I do not mean for a moment to imply anything against his intense receptivity for all physical ideas, for which he had a very great penetration. It is true that he sometimes met severe criticism from physicists. In particular Professor Tait made a bitter attack on his treatise on thermodynamics, but in my opinion Poincaré was well able to defend himself. It has sometimes been doubted whether he thoroughly appreciated Maxwell's ideas as to the theory of electricity, but this is of small moment, seeing that he so well understood their consequences. It must be said that Poincaré was not one who contributed fundamental new ideas to our stock of physical conceptions, such as the ideas put forth by Carnot, Kelvin, Maxwell, Lorentz with his principle of local time or Planck with his quanta.

I may in conclusion be permitted to state my opinion that the best persons to appoint to chairs of mathematical physics and those most likely to enrich our conceptions are those who have themselves had experience in dealing with nature with their own hands in the laboratory, and who may be expected to have more feeling for her modes of action than skill in analysis. Thus I believe Helmholtz, Kelvin, Maxwell, and Lord Rayleigh to have been more important contributors to mathematical physics than Poincaré, but this is not to say that the latter was not an intellect of superlative greatness.

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UNIVERSITY ORGANIZATION[1]

This subject has become in recent years one of intense interest. In most utterances on the subject the prominent feature is the statement that our universities are undemocratic, that they are monarchical institutions in a democratic country. This criticism takes various forms. When a university president speaks, the shortcomings of the university are due to the fact that the governing board are ignorant, shallow-minded, arrogant and headstrong; that they insist upon deciding matters beyond their knowledge and will not be guided by the president. When a university professor speaks it is the university presidency which is at fault. Autocracy, blindness, willfulness, prejudice, partiality, lofty-mindedness, oratorical ability, money-getting talents, piety and many other virtues and vices are ascribed to our presidents, but in the minds of nearly all writers the presidency is an unsatisfactory tool. When an outsider speaks, both president and governing board are parts of a vicious organization.

Let us grant that there is much truth in this. Boards may be unwise; the presidency may be unequal to its responsibili-

[1] With especial reference to state universities. An address delivered before a body of university men at Minneapolis, November 10, 1913.

ties and opportunities. Yet there is a third point of view, a more fundamental consideration. In the American university, as in the Russian political system, the chief difficulty is not with the autocrat, but with the bureaucrat. In my opinion, we can not go much farther astray than baldly to lay the shortcomings of our universities upon the president. As for the presidency, it is part of a great system; the president is the unfortunate occupant of an office.

Let us see how the matter stands. Any large institution such as one of our universities, in order to be successful, must have general aims or policies, must have an organization to carry them out, and must secure at once the successful operation of each of its subdivisions in its own sphere and the cooperation of each of these in the larger ends of the whole. The president is given, nominally at least, the responsibility of directing this organization in general and the right, when necessity arises, to intervene in the conduct of any of the parts in order to make them efficient and to adjust their relations with the remainder of the institution. Can any president do this under present conditions?

To bring about efficient work for desirable ends in any large institution certain things are necessary. First, a knowledge of what are the desirable aims or ideals for that institution and of how these ideals should be adjusted to the conditions of human life and to the life of the particular community from time to time. Second, a knowledge on the part of the executive of the workings of all parts of the institution and of the abilities of each member of the staff. Third, the possession of actual power by the executive to secure the cooperation of all parts in whatever is for the common welfare. This is true no matter whether the common welfare is found in the closest centralization or in the greatest freedom of individual action, no matter whether the executive is a president or a committee or takes some other form. Our universities must be organized, must have common ends and must exercise executive power, if the only end of that power be to secure anarchy. It is my purpose to inquire what is wrong with the present organization, that our universities should work so badly and that individuals should suffer so in the process.

Where does a university get its ideals or policies? Necessarily, they become the possession of the institution through the expression of ideas or opinions by members of the faculty and student body and through the accumulation of such ideas in the form known as traditions. Individuals in the university, whether president, instructors or students, necessarily furnish the ideas out of which common aims are constructed and in accordance with which old aims are adjusted to new conditions. Is there at the present time any adequate means by which the ideas of individuals can be made available for the common good? Two illustrations will answer the question in part. The head of a university department called together his entire staff including student assistants to discuss the organization of teaching with a view to improving the arrangement and content of the courses of study. The whole matter was discussed at two successive meetings, the professors talking over various plans without coming to any satisfactory conclusion. Instructors and assistants had been asked to think over the matter and at the second meeting each one in turn was called upon for suggestions. One assistant had a plan entirely different from anything that had been suggested. He outlined it and showed how it would improve the teaching and bring about a better correlation in

the work of the department. The men of professorial rank criticized the plan severely and the young man was made to feel that he was presumptuous in proportion as his plan was chimerical. After a rather long interval a third meeting was called. The head of the department announced that a plan had been devised, and proceeded to outline the identical plan which had been proposed by the assistant. It remained in effect for several years. Absolutely no hint of credit or recognition was ever given to the young man. Again, an instructor arose in general faculty meeting in an arts college in a state university and discussed a pending question at some length and with much coggency. His friends were filled with apprehension and one of them finally succeeded in signalling to the speaker to desist. He was afterwards informed by the dean that men below the rank of assistant professor were not expected to debate questions in the faculty. Instances might be multiplied to show that great difficulties stand in the way of the ideas of young men finding expression or receiving consideration in our universities. It is a well-known fact that in many departments the young men never know what plans are afoot until their duties are assigned them. And yet the young men are the only ones who can offer any new ideas to their institutions. Let it not be thought that the writer has any personal interest in this aspect of the question. He has passed the time when he can expect to produce any *new* ideas. Whatever new ideas he might have contributed to the universities with which he has been connected are lost forever,—unless indeed, ear is still given to what he might have said years ago. Of course, that is precisely what our mode of organization means. The university forbids a young man to speak until he becomes a professor. Then if he has not forgotten the ideas which came to him in the days of his youth and enthusiasm, or if the time for their application has not long gone by, the institution is willing to listen to him. That ensures conservatism,—but not progress. It means that the university never adjusts its ideals to the times but is forever denying itself the information which its individual members could supply.

If the university is slow and inefficient in securing information as to what should be its aims and policies, what about the sources of information for the executive as to how those policies are being carried out? The president depends for his information first upon the deans of colleges and schools, and second, upon the heads of departments. He depends upon these men also for executive functions under his direction. The president must depend upon these men for information, since he can not by any possibility know all the details by his own observation. Neither can he go personally to all individuals for information. In general the president is equally under the necessity of following the advice of his heads of departments, since otherwise he would lose their confidence and his only source of information. The president instead of being the autocratic monster that he is depicted, is in an almost pitiable situation. Unless he be a man of altogether extraordinary energy and strength of purpose, he is wholly at the mercy of his heads of departments. So far as the heads of departments are honest, wise and possessed of ideals for the common good the president is fortunate, and nothing that I may say in this talk can be construed as a criticism of such men. But heads of departments are endowed with human nature, and it is well known that they exhibit it in the conduct of their departments.

In one case a department of chemistry

was equipped with a great amount of expensive glassware and analytical apparatus of which the head of the department did not know the uses, while the students' tables were almost devoid of ordinary reagent bottles. The younger men in the department were unable for a long time to secure the ordinary equipment needed. In other cases men who were drawing full professors' salaries have taken their time for outside professional work or for dealing in real estate, coal or gas, neglecting their teaching and imposing extra work on the instructors to the detriment of both instructors and students. A head of department may carry on for years policies which are not approved by a single member of his staff; may absent himself from all teaching whatever; may neglect to do any research work or contribute anything to the advancement of his science; may pursue constantly a policy of selfish material aggrandizement for which the department suffers both in the esteem of the university and in the decrease of scientific work which the members of staff can do; may deliberately sacrifice the interests of the students to his personal ambitions, and may in these ways cause constant friction and great waste of energy throughout the college—all this while maintaining a pretense, or even a belief, that he is a most public-spirited and useful member of the faculty. The head may conduct his department in such a way as to make research impossible and even drive men out of his department because they do research, all the while that he himself talks of the importance of research. Heads may appoint to high positions men who have given no evidence whatever of their qualifications for the work proposed. Heads of departments and deans have been known to use their offices to secure advancement for their personal friends and are able to sidetrack valuable proposals for the common good which threaten to compete with their own interests.

The head of a department enjoys a remarkable liberty in the conduct of his department and in the performance of his individual duties. He may suppress the individualism of his staff members, ignore any suggestions which they may make, and dismiss them if they insist upon their ideas. He may falsify the reports as to the teaching and other work done by himself and by members of his staff. If subordinate members of the staff have different ideas as to the conduct of the departments they are vigorously overruled by the head, and if any question of bad policy or of injustice is brought to the stage of investigation by the president, that officer is governed by the principle that all matters of testimony must be construed by him in a light as favorable as possible to the head of the department. The president is bound to do this because he is dependent upon his heads of departments for information, advice and executive assistance. The "heads of departments" thus become a *system* which involves the president and from the toils of which he can not easily extricate himself. It is a matter of common knowledge that in some departments no member of staff is asked for his opinions or is encouraged to hold or express independent views, that younger members of the faculty commonly dare not express themselves publicly or go to the president or dean in matters in which they differ from the heads of their departments, and that generally the department head assumes that the decision of any question resides with the "responsible head," regardless of the views of his subordinates. There is no way in which the members of staff can influence the policy of their department, there is no chan-

nel by which the facts can be brought effectively to the notice of the president or governing board, and there is no assurance in our present form of organization that the welfare of the staff or their opinions as to the welfare of the university, would receive consideration if opposed to the desires of the department head. All this is expressed in common university parlance by saying that the head regards the department as his personal property and the members of staff as his hired men.

I believe that a truer statement of the case is this. Some years ago each subject was taught by a single professor. The growth in the number of students made it necessary to appoint new instructors to assist the professor. At first these assistants were very subordinate in years and experience and it was only natural that the responsibility for the work of the department should remain with the professor. With further growth of the institution the department staff has come to include several instructors and professors, each of whom has a primary interest and responsibility in the welfare of the department and of the institution. Instead of this being recognized, the full powers of the department have been left in the hands of the original head. These heads have in consequence come into control of the sources of information to the executive, have jealously guarded their great powers, and are able to direct departmental and university policies through holding the president in ignorance and their subordinates in contempt. In other words, university control has come to be vested in a system of *ir*responsible heads of departments. This was what was meant in the beginning by saying that the difficulty lies not with the autocrat, but with the bureaucrat. More than one well-meaning university president has recognized the situation, admitted his powerlessness at critical periods and has sought to extricate himself and his university by having recourse to private interviews and by the appointment of advisory committees.

If the only evils of this system were that it entails upon the president great difficulties of university management and results in the misdirection of department affairs and the waste of material resources, it would not be so intolerable. Its more serious effects are that it lowers the efficiency and the moral and spiritual tone of the whole institution, that it wastes the time and energy of whole staffs in order that the head may take his ease or satisfy his ambitions. Moreover, taking away from faculty members the responsibility for the conception and execution of university policies is the best possible way to break down the practical efficiency of these men and to reduce the college professor by a process of natural selection to the impractical, inexperienced hireling that he is popularly supposed to be. Whether this is in part the cause of the wretched teaching which is done in our universities and of the lack of standards of work and of character for the student, I leave you to judge.

There is a second unfortunate feature in our university organization to which I will give only brief attention. This is the prominence of the colleges and schools and the sharp boundaries between them. The colleges are not based upon any natural subdivision of knowledge, but upon practical or technical grounds. Each college has in view the esteem of its own profession and has little sympathy with other colleges which make up the university. The very existence of the colleges creates special interests and produces strife which is in no way related to the welfare of the student or the general public. Teaching

and equipment—apparatus, supplies, library—are duplicated, the natural relations of fields of knowledge are subordinated to the practical application of specific facts and laws, college walls and college interests intervene to prevent the student from following co-related subjects in which he is interested, professional interests and professional ideals begin early to narrow the student's vision and to substitute professional tradition and practise for sound judgment and an open mind. All this is unfortunate. The professions should foster but not confine their apprentices. A student preparing for professional work should have the advantage of the traditions and practises prevailing in the profession, but those traditions and practices should not constitute limitations on his opportunities, his enterprise or his initiative.

A third evil tendency in our universities is the growing complexity of administrative organization. Good results can not be secured by relying chiefly on a system of checks and safeguards. These can not replace capability, honesty and a genuine interest in the university's welfare. Checks and safeguards can at best only prevent some abuses, while they certainly place obstacles in the way of men who would do honest work. It is of doubtful value to set a sheep dog to keep cats from killing young chickens—especially when the main business of the university is not to raise either sheep or chickens but to rear *men*. There is a constant danger that good men will be obliged to kotow to administrative officials who ought to be servants but who proclaim themselves masters. To appoint capable men and to place confidence in their concordant judgment would at once prevent the abuses and secure the desirable ends.

FUNDAMENTAL PRINCIPLES UPON WHICH UNIVERSITY ORGANIZATION SHOULD REST

The functions of a university are three. First, to bring together teachers and students under such conditions that the whole field of knowledge is opened to the student and he is offered competent and reliable advice and assistance in his studies. The second function arises from the responsibility for the competent direction of the student's work. The university must examine the foundations of its authority by making original investigations to test, correct and enlarge the existing body of knowledge. No institution which neglects to prosecute research in as many fields as practical conditions permit, is worthy of the name of university. The third function of a university is to make its store of knowledge practically available to its community and patrons and to stimulate in the members of the community an interest in the further acquisition of knowledge.

The university is thus concerned with knowledge and its applications. University organization exists for the purpose of securing suitable conditions for research and teaching, for the acquisition and the application of knowledge. Certain of the conditions of successful work in a university may be laid down without argument. First, that each individual instructor or student should enjoy freedom and bear responsibility in his work, *i. e.*, he should be judged by his achievements. Second, the recognition of the facts that dealing with knowledge is the central function of the university; that all organization must contribute to this end; that the teacher, the student and the research worker are the sole persons of primary value in the university; that all administrative officers are accessory machinery; that all organization should spring from those primarily engaged in the

university's work; and that all authority should rest with these and with the community which supports the institution. This organic relation of the actual workers to the university government is at once a natural right and the foundation of that personal interest and enthusiasm which are necessary to successful endeavor. Note that I do not say that the instructor and research worker should be *made to feel* that he has an interest in the university organization and a part in university policies through his advice and so forth, but that the teacher and research worker is in the nature of things the actual source of authority in the university, conditioned only by the relations of the university to its community.

What, now, is the proper form of university organization, and how can it be approached in our state universities?

The governing board should represent both the community served and the university. The people of the state furnish the financial and spiritual support for the university and receive the benefits of its work. The support can be withheld whenever the returns are unsatisfactory. The interests of the people do not require to be protected by the governing board. The members of the university faculties contribute their lives, and receive in return a living wage. It is only with the greatest difficulty that they can withdraw their investment in the enterprise. They furnish also the plans of work and the expert direction. The nature of the work is such that it is essential that the staff should have a free hand in executing its plans and should be responsible to the people for its achievements. It seems clear that a governing board composed of three members appointed by the governor from the state at large, three members elected by university faculties from their own number, and the president, would at least not err on the side of giving too great autonomy to the university. It is clear that complete autonomy would carry with it the danger of losing touch with the university's constituency, while the presence of an equal representation from the university and the state would free the faculty permanently from the stigma of control by "non-scholar trustees." Those present well know, however, that boards of the existing type may show an excellent spirit and judgment.

The internal organization of the university should have reference solely to efficiency in teaching and research. The organization should be created by the members of the staff by virtue of their sovereign powers within the institution. The first natural subdivision of the university is that into departments based upon the relations of the fields of knowledge. The process of subdivision of subjects and creation of new departments has gone too far and must be reversed. Under the old order of things the only way for a man of parts to gain recognition and influence which he was capable of using, was to become the head of a department or the dean of a college. This accounts for the creation of many new departments and schools for which there was no need. Administration could be simplified, duplication of work, apparatus, books and supplies could be avoided, and a closer correlation and a better spirit and more stimulus to scholarly work could be secured by the creation of larger departments based on close relationship of subject-matter.

The staff of such large departments might number ten, twenty or more men. In the nature of things the organization within such a department is based upon the personal interest of each member of the staff in the success and welfare of the department, and its object should be to place the resources of the department in

the fullest degree at the command of the student and to facilitate research. These things can be secured only where there is harmony among the staff and where the ideas of the staff are carried out in the administration of the department. Harmony of ideals and executive representation can be secured only by the *election* both of new members of the staff and of the administrative head of the department. New members of staff should be nominated to the president by those who will be their colleagues and who are best able to judge of their fitness for their places. The president will of course actively share the responsibility of appointments. Promotions should be recommended by the chairman and approved by a university committee on promotions.

All important business should be done in staff meetings. The chairman should administer department affairs according to the decisions and by the authority of the staff and should *represent* the staff in relations with other departments. Within the department there should be the greatest practicable freedom of the individual in teaching and research, together with publicity of results. Subdivision of the field covered by the department, organization and assignment of work would be done in staff conference. Publicity regarding the number of elective students, percentage of students passed and failed, average grades given, research work accomplished, and so forth, would furnish opportunity for comparison, friendly rivalry, self-criticism and improvement of the work of each teacher. The first step toward improvement of organization of state universities would be the organization of department staffs to bear the responsibilities and to direct the work of the department through an elected chairman. The second step would be the gradual combination of smaller into larger departments.

The next important step would be the breaking down of the boundaries between colleges on the side of teaching and investigation, making each student perfectly free to study where and what he will, subject only to the regulations of departments and to the means of gaining his own ends. Some present schools and colleges would take again their proper places as departments, the others would be dissolved.

So far as the present colleges serve a useful purpose their place would be taken by faculties for the supervision of professional and degree courses. Each such faculty should be made up of representatives of all departments which may offer work toward the given degree, such representatives to act under instructions from the staffs of their respective departments. These faculties should prescribe requirements for entrance and for graduation but should have no control of finances or of appointments. They should exercise only an advisory function in regard to the election of studies or the student's use of his time. Any faculty might, if it was deemed advisable, prescribe final examinations over the whole course of study, or the presentation of a thesis, and so forth. Thus we should have an A.B. faculty, an LL.B. faculty, an M.D. faculty, and so on, each safeguarding the traditions which surround its degree or the standards which should be upheld in the profession, but each giving full opportunity to the various departments to place before the student new materials, methods and ideals; and giving to the student opportunity to try his powers and extend his acquaintance beyond the usual limits laid down by the traditions of his degree or his chosen profession. This mode of organization would also make it as easy as possible for the student to change his course in case

he found that his choice of a profession was unsuited to his individual talents.

In such an organization the university senate might have somewhat enlarged powers and more detailed duties. The administrative functions now exercised by the faculties and deans of colleges would in part vanish, in larger part be transferred to the several departmental staffs and in part devolve upon the senate either in the first instance or through reference from departments. The senate would continue to be a court of appeal in cases of dispute between faculties or departments. The establishment of new degrees or degree-courses would require action of the senate, and sweeping changes in any curriculum or the membership of any faculty should have the approval of the senate. For example, the university could not establish a new school of naval architecture or of mental healing or of colonial administration each leading to its special degree, without the sanction of a body representing the whole university. Neither could the faculty of arts radically change the character of the course leading to the A.B. degree, either by the ingestion or the extrusion of a large group of departments, without such action being subject to review by the university senate. More need not be said on this phase of the subject. It seems clear that with the greater freedom of action on the part of students and departments, with special faculties laying down regulations for the various degree-courses, with the elimination of rivalries and strife growing directly out of the organization by colleges, the problems of internal correlation and control would be greatly simplified and could readily be cared for in a senate organized very much as ours is at present.

Simplification in university work and administration is the crying need next to independence and responsibility of the members of the faculty. The endless red tape of business administration could be largely done away with by the logical completion of the budget system. The budget having been made by the governing board, each department should be perfectly free to expend its own quota of funds by vote of its staff without supervision or approval of anybody—and should be held responsible for the results secured from year to year. Nobody can know so well how money should be expended as the staff who are to use the things purchased, no one knows so well where to get things or how to get them promptly when needed, none feels so directly and keenly the effects of misuse of money, none will so carefully guard its resources as the department itself. The dangers of duplication will be set aside by the better correlation of departments already suggested. In establishing common storerooms, purchasing agents and the like, the first and chief step should be to ask of the members of the staff throughout the university, how can the administration help you in your work through such agencies as these, instead of thinking how these agencies can remove from the departments the ultimate control of their work. Time and money may be wasted at a frightful rate through fear to place responsibility and confidence where they belong—a fear which is well-founded on our present system of irresponsible heads of departments.

Simplification in the administration of teaching would be favored by the dissolution of the colleges and the setting free of the elective system under a few simple regulations as to the combination of elementary and advanced courses and of major and cognate work which would be necessary for an academic degree, and as to the prescribed curriculum in a professional course. What is needed is fewer regulations and

better teaching; fewer snap courses, fewer substitutions and special dispensations; less care for the poor student and more food for the good student; less interest in sending forth graduates and more measuring up of students against standards of honesty, industry and self-judgment.

Finally, the presidency. Shall the president be elected by the faculty? Shall his actions be subject to review by the senate? Shall he have a veto power over the senate? Shall his duties be limited to those of a gentleman, orator and representative of university culture, or to those of the business agent and manager? The discussion of these questions seems to the writer to be of minor importance. With such a governing board and such an internal organization as has been briefly outlined, it can scarcely be doubted that the president will be representative of his faculty or that he could secure intelligent action from the board. Nor would it be difficult for the president to be a leader in whatever ways he was fitted for leadership or in whatever matters leadership was required. It seems to me that the presidency should be controlled by unwritten rather than by written laws. What is essential is that the university have a strong executive; strong in the discovery and application of right principles, strong in his reliance upon the consent and the support of the governed and strong in the execution of their ideals. The remedy for our evils is not to object to a strong executive, but to remove the necessity for an arbitrary executive; not to cry out for anarchy, but to introduce self-government.

Allow me to recapitulate. Our universities are laboring under a bureaucratic form of government in which the initiative rests chiefly with the heads of departments, in which there is a constant struggle for power among the bureau heads, in which these same heads are the chief source of information and advice to the executive, in which most of the faculty have no voice in framing policies, and in which—at its worst—the student is concerned only to be counted and the public only to be milked. The extreme of degradation is reached when research is wholly neglected and teaching is regarded as only the excuse for material aggrandizement. The bad state of affairs which we see every now and then in this or that department or college in all our universities can not be regarded as the free choice of any average group of men. I can not conceive of any of these things being voted by members of a staff. These conditions are the result of the arbitrary power placed in the hands of single men without check or publicity. Such a system always breeds dishonesty and crime. The remedy is to recognize the primary interest of every member of the staff and to establish representative government in the university. On the whole and in the long run the combined judgment of the members of the staff of any department is sure to be better than that of any individual. Self-government stimulates individual initiative and calls forth ideas for the common good. The enjoyment of freedom and responsibility will make of our faculty morally strong and practically efficient men, and will call into the profession capable men, men robust in intellect and imagination, instead of the weaklings who now barter their souls for shelter from the perils of a competitive business world.

It may be true in a legal sense that the state through the board of regents now hires the members of the university faculty. But men to do university work *can not be hired.* Those of the faculties who now do university work do it not because they are paid living wages, but because they love the work. It has been one of the great fallacies of human history to suppose that workmen

can be hired. When you hire or enslave a man you secure only mechanical service. The world's work can not be done by hired muscle alone, but requires personal interest, moral character and entire manhood. Slaves survive in their pyramids, their temples and their papyri, where their masters have perished. The successful and progressive civilizations of to-day are founded on the freedom and self-satisfaction of the individual. The most acute problems of modern society arise out of the hiring of men to do work which they would much prefer to do for themselves and would do better for themselves. These things bear their lessons for universities, if we will heed them. Freedom of speech and complete self-government are necessary to the best interests of a university. A whole staff is together more capable than any one man. Suppression of staff members who speak without authority of the head is the suppression of truth and initiative. It has resulted and must result in the selection of weak men for the faculty and in narrowness, bigotry and provincialism in the institution. Self-government will draw strong men into the faculty, will stimulate initiative, will make possible and encourage progressive administration, and will bring to mental endeavor on the part of both student and teacher the freshness of the morning air, the pursuit of a goal of one's own choosing, and satisfaction in the achievement of one's ideals.

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THE FUR-SEAL CENSUS FOR 1913

In the summer of 1912, for the first time, a complete enumeration of the breeding stock of the fur-seal herd of the Pribilof Islands was made. Prior to that season estimates of the herd were based upon a full count of harems, to which an average harem, obtained by counting individual animals upon a part of the breeding ground, was applied. The rookeries counted were naturally the smaller and more scattered ones and the average harem derived from them did not fairly represent the larger rookeries. The importance of the annual estimates, however, lay in the measure of decline which they afforded, and for this purpose they were as useful as exact counts would have been.

The treaty of July 7, 1911, suspended pelagic sealing, the cause of the herd's decline, and it was natural to expect a cessation of decline and the beginning of growth toward recovery. The exact condition of the breeding stock at its lowest point became, therefore, in 1912, a consideration of the greatest importance. A count of all the breeding families, which was in effect a count of the breeding males, was easily made, but the females come and go in the sea and are never all on the land at one time. They furthermore could not be counted accurately, if they were all present, as they can not be herded or driven. Their direct enumeration, therefore, is an impracticable thing. The young pups, however, are timid of the water during the first month or six weeks of their lives and do not go into it. After the breeding season is over, that is, early in August, the mothers can be driven off and the young herded and handled like sheep. As each pup represents a mother, the problem became merely one of counting all the pups. This was accomplished and an account of the work for 1912 was given in the December 27 issue of Science.

As the census of 1912 was important to give exact information regarding the breeding stock at its lowest point, so a repetition of this census in 1913 became important to establish a measure of increase or expansion in this breeding stock. The total number of pups found in 1912 was 81,984. For the season of 1913 the total was 92,269, a gain of 12½ per cent. The normal annual gain of the herd arises from the accession of young three-year-old females coming upon the rookeries each season to bear their first pups. The theoretical rate of gain, as deduced from the quota of three-year-old males, taken in recent years,

should be about 25 per cent. The breeding life of the female is about 10 years. Approximately 10 per cent. of the adult stock of females disappear in each winter migration through natural termination of life, and the net gain of the herd should be about 15 per cent. That the gain of 1912 is 12½ per cent. instead of 15 is explained by the fact that the increment of three-year-old females for the past season was derived from the birthrate of 1910, when pelagic sealing was still in operation and pups in considerable numbers died unborn with their mothers or starved to death on the rookeries later because of the death of their mothers. In short the season of 1913 has not been quite normal. The season of 1914 should show normal conditions because its increment of gain will come from the birthrate of 1911, the first season under exemption from pelagic sealing. If the count of pups is repeated for that season, the normal rate of gain will be established.

All elements in the fur-seal census can not be measured by counts. The bachelor seals of four years and under, and the young females of two years and under, come and go from the sea in an irregular fashion which makes counting impossible. A basis of reasonably accurate estimate for these classes of animals, however, rests in the data arising from the quota of killable seals, and counts of animals rejected at the killings as too small or too large. Utilizing this form of estimate to supplement the counts of bulls, cows and pups, the appended completed census of the fur-seal herd is obtained, the figures for both 1912 and 1913 being given for purposes of comparison.

The stock of breeding and reserve bulls in 1913 shows an increase adequate to meet the needs of the expanding herd. The relation of the two sexes on the breeding grounds has in this season been more nearly ideal than at any time in the past 17 years. Could present conditions remain undisturbed, accurate information regarding the herd's future condition would be certain. Unfortunately this is not to be. The suspension of land killing, incorporated in the law of August 24, 1912, will break the present equilibrium and throw all factors of the problem into new confusion, by swamping the breeding grounds with an overstock of idle bulls. The real effect of the suspension is not at present visible, except in that the hauling grounds were in 1913 filled with superfluous young males, the killing of which was prevented by law. Ten thousand of these

FUR SEAL CENSUS

Class of Animals	Basis of Enumeration	1912	1913
Breeding bulls	Count	1,358	1,403
Breeding cows	Count	81,984	92,269
Reserve bulls—young	Count	199	259
Reserve bulls—adult	Count	113	105
Pups	Count	81,984	92,269
Bachelors—4-year-olds	Count and estimate	100	2,000
Bachelors—3-year-olds	Count and estimate	2,000	10,000
Bachelors—2-year-olds	Count and estimate	11,000	15,000
Bachelors—1-year-olds	Estimate	13,000	20,000
Young cows—2-year-olds	Estimate	11,000	15,000
Young cows—1-year-olds	Estimate	13,000	20,000
	Totals	215,738	268,305

animals (with skins worth $350,000 to $400,000), were left to grow up as useless fighting bulls, and this condition is to be multiplied through four more seasons. Its consequences ten years hence will prove a veritable calamity to the herd.

Leaving aside this discouraging feature of the situation, however, it is a source of genuine gratification that the suspension of pelagic sealing, accomplished by the treaty of 1911, has been so immediate and salutary in its effect. Not merely has the decline on the Pribilof Island rookeries—persistent through 30 years—been stayed, but the breeding herd has taken on a rapid growth. Its initial stock of 92,000 breeding females makes a splendid nucleus and will compound at an annual rate of 15 per cent.

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November 29, 1913

EDWIN KLEBS (1834–1913)

With the death of Edwin Klebs at Bern, Switzerland, on October 25, 1913, there passed away the last of the great pioneers of the bacterial theory of infection, a pupil of Virchow, a contemporary of Pasteur and, in a very definite sense, the inspirer of Koch. Born at Königsberg in 1834, Klebs was an East Prussian and the peculiar effect of his character upon his work, a certain discontinuity in the latter, was due to the Slavic element in his composition. He was a peripatetic all his life and, after serving as Virchow's assistant at Berlin (1861–66), he was successively professor of pathology at Bern (1866), Würtzburg (1872), Prague (1873), Zurich (1882) and Chicago (Rush Medical College, 1896), after which he lived in retirement at Dortmund and Bern. During all this time he was a prominent worker in all branches of pathology and in the truest sense a precursor in the bacterial theory of disease. Indeed, his greatest service to medicine was, perhaps, the important influence he exerted upon the pathologists of his time, leading them away from the solidist theories of Virchow and winning them over to the view that post-mortem findings are only end results and that infectious diseases are caused by microorganisms and their chemical products. Koch himself admitted, in a private letter, that he owed much to Klebs, who had been the actual path-breaker in many of the new fields followed by the younger men. Up to 1876, Klebs was the leading protagonist of the modern theory of specific infections (Pasteur did not begin to work in anthrax until about 1880), and, by actual priority of publication, he preceded Koch in the study of bacterial wound infections (1871) and in the technique of growing bacterial cultures in special media (hens' eggs in the first instance). During his Würzburg period, his idea of obtaining pure cultures of pathogenic microorganisms was actually laughed at as an idle dream. Long before Pasteur and Joubert, he showed that the blood of anthrax is not pathogenic after filtration (1871); in other words that the virus of the disease is non-filterable. From this idea, it was but a step for Loeffler to reason and to prove that diseases may be caused by "filterable viruses" (1898). Klebs saw the typhoid bacillus before Eberth (1881), the diphtheria bacillus before Loeffler (1883), investigated the tubercle bacilli of cold-blooded animals and their therapeutic possibilities before Friedmann (1900), inoculated monkeys with syphilis before Metchnikoff (1878), first investigated the bacteriology of gun-shot wounds (1872), first produced bovine infection of *Perlsucht* by feeding with milk (1873), first investigated the infectious nature of endocarditis (1878), and made the first exhaustive study of acromegaly (1884). Meanwhile, his two pathological treatises of 1869–76 and 1887–89 were acknowledged masterpieces in the older field of descriptive or morphological pathology, of which he was the leading exponent after Rokitansky and Virchow and in which Chiari is one of the few surviving workers. Klebs's definite abandonment of the solidist or "end result" pathology dates from his discourses of 1878 and 1882, which are definitely contra-Virchow, although nothing could be more courteous and reasonable than his attitude in joining issue with his old teacher and friend. In bringing the weak-kneed over to the modern view, his propagandism was of the broadest and most impersonal character. After 1876–8, Klebs's work was definitely overshadowed by Koch's great papers on anthrax and the traumatic infectious diseases, and his influence began to wane. It may be asked, why did this remarkable man not reap the fruits of his brilliant labors? Why is he not better known to-day? Some may find the answer in Lord Woolsey's dictum that "he alone is a good general who follows up his victories." But this reproach can not entirely be cast up to Klebs. His work was constantly interrupted by such occurrences as the revolution in Prague and the intrigues and internecine wrangles which sometimes go on among university professors. His temperament was restless, sensitive, impulsive and combative, and, being wrapped up in the original ideas which were always coming to him, he had a tendency to leave work of an important character to his assistants, which was not to his advantage.

Some of his ideas about infection, *e. g.*, his "bacillus malariæ," his "microzoon septicum" (wound infections), his "monadines" (rheumatic affections), turned out to be wrong, and where he struck into some good lead, as in diphtheria or typhoid, he was perhaps for this very reason little inclined to follow it up. Yet, all in all, Klebs was one of the most original spirits in modern medicine, a man who paid dearly for his unshakable confidence in humanity and his tendency to fight in the open, an opponent who soon forgot differences with his fellows and never cherished ill-will. He will remain where Osler has placed him as a great pioneer. He had a prophetic vision into the future and a fine historic sense, looking, as Wordsworth said of the poet, "before and after." His discourse on the history of medicine, delivered at Bern in 1868, may be likened to the little book of Stopford Brooke on Engish literature, as being the most delightful primer of the subject (as dissociated from surgery and the specialties) ever written. It deserves to be translated. Klebs was a founder and co-editor of the *Correspondenzblatt für schweizerische Aerzte* (1871), the *Prager medicinische Wochenschrift* (1876), and he was, with Naunyn and Buchheim, a founder and for many years co-editor of the important *Archiv für experimentelle Pathologie und Pharmakologie* (1872). Naunyn, the distinguished clinician of Strassburg, who was Klebs's colleague at Bern, refers to him in the following terms:

> Ein langes Leben reich an Arbeit und an Unruhe. Wie er es sich selbst geschaffen, so hat er es hingenommen, ohne sich beugen zu lassen, ein aufrechter Mann bis an seinen Tod. Uns, seinen Freunden aus alter Zeit, sind sein offener Sinn, sein sprühender, anregender Geist, sein warmes Herz eine liebe, dankbare Erinnerung.

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SCIENTIFIC NOTES AND NEWS

THE annual meeting of the Physical Society will be held in Atlanta, Ga., December 29–January 3, the society meeting in joint session with Section B of the American Association for the Advancement of Science. The place of meeting will probably be the Georgia School of Technology. The program of ordinary technical papers will be in charge of the Physical Society, but two, or perhaps three, sessions will be in charge of Section B. These will be devoted to papers of general scientific interest, relating especially to some of the larger problems of geophysics. The program of the meeting will include the address of the president of the Physical Society, Professor B. O. Peirce, and that of the retiring vice-president of Section B, Professor A. G. Webster.

M. PAUL OTLET, of Brussels, sécretaire de la Union des Congréses Internationales, who represented the Union at the Dundee meeting of the British Association for the Advancement of Science, will be present at the Atlanta meeting of the American Association for the Advancement of Science and will address the association on the subject of the international organization of scientific activities.

THE meeting of the Paleontological Society at Princeton will include a symposium on "The Close of the Cretaceous and Opening of Eocene in North America" with an introduction by Professor H. F. Osborn and Messrs. F. H. Knowlton, T. W. Stanton, W. J. Sinclair and Barnum Brown leading the discussion.

FOR the Australian meeting of the British Association in August next year, under the presidency of Professor W. Bateson, F.R.S., the following presidents of sections have been appointed:

Section A (Mathematics and Physics), Professor F. T. Trouton.
Section B (Chemistry), Professor W. J. Pope.
Section C (Geology), Sir T. H. Holland.
Section D (Zoology), Professor A. Dendy.
Section E (Geography), Sir C. P. Lucas.
Section F (Economics), Professor E. C. K. Gonner.
Section G (Engineering), Professor E. G. Coker.
Section H (Anthropology), Sir Everard im Thurn.
Section I (Physiology), Professor C. J. Martin.
Section K (Botany), Professor F. O. Bower.
Section L (Educational Science), Professor J. Perry.
Section M (Agriculture), Mr. A. D. Hall.

At the annual meeting of the New York Academy of Sciences on December 15, Dr. George F. Kunz was elected president. Vice-presidents for the sections were elected as follows: Professor Charles P. Berkey, Professor Raymond C. Osburn, Professor Charles Baskerville and Dr. Clark Wissler.

Dr. R. R. Gates has been awarded the Huxley gold medal and prize for research in biology at the Royal College of Science, London.

The special board for biology and geology at Cambridge University has adjudged the Walsingham medal for 1913 to Mr. Franklin Kidd, B.A., fellow of St. John's, for his essay entitled "On the Action of Carbon Dioxide in the Moist Seed in Maturing, Resting, and Germinating Conditions."

Mr. H. S. Jones, B.A., now one of the chief assistants at the Royal Observatory, Greenwich, has been elected to a fellowship at Jesus College, Cambridge.

Dr. W. Dawson Johnston has resigned the librarianship of Columbia University to become librarian of the St. Paul Public Library.

Professor A. W. Whitney, of the University of California, has resigned to accept a position in the state board of insurance.

Professor Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, has been made chairman of the educational committee on Chicago philanthropy, which was recently organized to keep the public informed of the needs of the city's poor.

Professor Clara A. Bliss, of the department of chemistry of Wells College, has been granted leave of absence for the year, and Miss Minnie A. Graham, formerly professor of chemistry at Lake Erie College, is substituting for her as head of the department.

The magnetic survey vessel, *Carnegie*, has returned to Brooklyn, thus completing the circumnavigation cruise begun in June, 1910, and covering a distance of over 70,000 miles. The vessel has been throughout under the command of W. J. Peters, and her work has been to determine the magnetic elements at sea in fulfillment of the plan of a general magnetic survey of the globe under the direction of the department of terrestrial magnetism of the Carnegie Institution of Washington.

A magnetic expedition covering a greater part of the District of Patricia, Canada, was undertaken this summer by the department of terrestrial magnetism and brought to a successful conclusion under the charge of Dr. H. M. W. Edmonds, assisted by Observer D. M. Wise. A particularly interesting and important feature of this field work was the proximity of the line of observations to the supposed region of maximum total intensity first disclosed by Lefroy in 1845. The party left Washington May 16, 1913, and returned at the end of October. The main part of the work comprised the canoe route of approximately 2,000 miles, of which over 500 miles was over an unsheltered open coast along Hudson Bay and James Bay from Fort Severn to Fort Albany. Complete magnetic observations were secured at 38 different points.

The annual lecture before the Carnegie Institution of Washington was given on December 16, in the assembly room of the Administration Building on "Measurement of Environic Components and Their Biologic Effects" by Dr. D. T. MacDougal, director of the Desert Laboratory, Tucson, Arizona.

The department of anthropology of the American Museum of Natural History, New York City, offers a course of four lectures dealing with the social and religious customs and beliefs of primitive peoples. On January 8 and 15, Dr. Robert H. Lowie will lecture on "Social Organization," and on January 22 and 29 Dr. Pliny E. Goddard will lecture on "Religious Observances" and "Religious Beliefs."

Professor W. W. Atwood, of Harvard University, presented on November 29 to the Chaos Club, an organization composed of the members of the science faculties of the Universities of Illinois, Wisconsin, Northwestern and Chicago, an account of his recent discovery of glacial material of Eocene age in the San Juan Mountains of southwestern Colorado. This Eocene till is the only evi-

dence that has thus far been found in the world of a glacial period at that time in the history of the earth.

"THE Strength and Weakness of Socialism" was the subject of an address by Professor Albion W. Small, head of the department of sociology and anthropology in the University of Chicago, delivered on December 23 in the Fine Arts Theater, Chicago, under the auspices of the University Lecture Association. On January 6, Professor James R. Angell, head of the department of psychology, will speak in the same place on the subject "Practical Applications of Psychology."

THE family of the late Dr. Alfred Russel Wallace having invited Mr. James Marchant, of Lochnagar, Edenbridge, Kent, to arrange and edit a volume of letters and reminiscences, those who have letters or reminiscences are requested to send them to him. The letters would be safely and promptly returned.

THE twenty-fifth anniversary of the Institut Pasteur was celebrated November 13. Speeches were made by the president of the republic and Dr. Roux, director of the institute.

THE descendants of Priestly, the discoverer of oxygen, have presented to the University of Pennsylvania the chemical balance which was used by him in his experiments.

AT the fifth International Congress of Mathematicians, held at Cambridge, it was decided that the sixth congress should meet at Stockholm in 1916. The king of Sweden, who has bestowed his patronage upon the congress, has decided to honor, by means of a gold medal with the likeness of Karl Weierstrass and by a sum of 3,000 crowns (about $825) some important discovery in the domain of the theory of analytical functions. Those who wish to compete must send their manuscripts to the chief editor of the *Acta Mathematica* before October 31, 1915, the centenary of the birth of Karl Weierstrass.

THE council of the British Association, acting under authority of the general committee, has made the following grants out of the gift of £10,000 made to the association for scientific purposes by Sir J. K. Caird at the Dundee meeting of the association last year. (1) £500 to the committee on radiotelegraphic investigations. (2) An annual grant of £100 to the committee on seismological investigations, which is carrying on the work of the late Professor John Milne. (3) An annual grant of £100 to the committee appointed to select and assist investigators to carry on work at the zoological station at Naples. (4) £250 towards the cost of the magnetic re-survey of the British Isles, which has been undertaken by the Royal Society and the British Association in collaboration.

UNDER the auspices of the international commission a congress on the teaching of mathematics will be held at Paris, April 1–5, 1914, in the halls of the Sorbonne. The chief subjects of discussion will be the introduction of the first notions of the calculus and of primitive functions in the secondary schools, and the teaching of mathematics to engineering students.

AN international conference met in Paris on December 10 to discuss the question of a map of the world on a millionth scale. General Laffon de Ladebat, who is director of the geographical service of the French army, welcomed the delegates of the thirty-two countries represented on behalf of the government, and Colonel Close, the chief English delegate, replied. The first conference was held in 1909 in London, and since then specimen sections of the map have been prepared. These were produced for inspection. The scale proposed is equal to 15 miles to the inch.

THE International Electrical Congress is to be held at San Francisco from September 13 to 18, 1915, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrochemical Commission, and during the Panama-Pacific International Exposition. Dr. C. P. Steinmetz has accepted the honorary presidency of the congress. The deliberations of the congress will be divided among twelve sections which will deal exclusively with electricity and electrical practise. There will probably be about 250 papers. The first membership invitations will

be issued in February or March, 1914. Attention is drawn to the distinction between this Electical Congress and the International Engineering Congress which will be held at San Francisco during the week immediately following the electrical congress. The engineering congress is supported by the societies of Civil, Mechanical and Marine Engineers and by the institutes of Mining and Electrical Engineers, as well as by prominent Pacific Coast engineers who are actively engaged in organizing it. This congress will deal with engineering in a general sense, electrical engineering subjects being limited to one of the eleven sections which will include about twelve papers, treating more particularly applications of electricity in engineering work. The meeting of the International Electrotechnical Commission will be held during the week preceding that of the Electrical Congress.

The third volume of the "Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological," published by the International Commission of the Seventh and Eighth International Congresses of Applied Chemistry is now in press and will be issued in the first half of 1914. A descriptive circular with references to reviews of previous volumes may be secured on application to the University of Chicago Press. The commissioners for the United States are: Julius Stieglitz, the University of Chicago; Edward C. Franklin, Leland Stanford University; Henry C. Gale, the University of Chicago, and Albert P. Mathews, the University of Chicago.

Beginning with January, 1914, the American Breeders' Association will be known as the American Genetic Association. At the same time (starting with Vol. V., No. 1) *The American Breeders' Magazine* will be enlarged in size and called *The Journal of Heredity*. The cooperative nature of the association will remain unchanged, and the present scope and character of the magazine will be maintained, but its quality will be still further improved.

A bacteriological club has recently been organized at the University of Illinois with a membership of fifteen. The organization held its first meeting on Monday evening, December 8, at which an address was given by Dr. Thomas J. Burrill who reviewed the history of bacteriological research. Membership in this club is open both to faculty and to graduate students. Earlier in the year a similar society was organized for the purpose of studying botanical subjects.

The National Physical Laboratory, Teddington, is in possession of the British radium standard, which has been certified by the International Radium Standards Committee after comparison with the international radium standard now deposited at the Bureau International at Sèvres. The laboratory is prepared to determine the contents of radium and mesothorium preparations by comparison with the standard.

Within the last month the University of Arizona has installed a Callendar pyrheliometer with a Leeds and Northrup recording galvanometer. This type of pyrheliometer consists of a horizontal surface, measuring the vertical component of sky radiation. This surface is made up of two platinum resistance circuits, one blackened, the other bright, mounted in a vacuum. These two circuits form two sides of a Wheatstone bridge, the resistance necessary to balance the bridge being recorded on the sheet. The recording galvanometer has five ranges, one adjusted to this pyrheliometer and the others to various forms of resistance thermometers. The instruments were purchased on the income of a fund presented by Dr. James Douglas, of New York. For standardizing the records, the university has also a Smithsonian silver disk pyrheliometer. It is designed thus to have a permanent record of sky radiation, not only for the purpose of getting data regarding solar energy in that dry and exceptionally clear climate but also for checking any suspected large variations in the solar constant.

UNIVERSITY AND EDUCATIONAL NEWS

An addition to the resources of the University of Chicago is the completion of the addition to the Ryerson Physical Laboratory, and the reconstruction of the other part of that building. This work increases the re-

sources of the laboratory for research at least threefold. The cost of the addition and reconstruction was about $200,000, and was the gift of the president of the university board of trustees, Mr. Martin A. Ryerson.

FOUR distinct building projects are going forward at the Carnegie Institute of Technology, involving an expenditure of approximately $750,000. The concrete foundations are now ready for the steel work in the central building and on the new wing for the Margaret Morrison Carnegie School for Women. The former is to be occupied by the general executive offices and a students' union. Machinery Hall, to house the electrical and mechanical engineering departments, is nearing completion. The high tower, the last piece of work to be done on this structure, will be finished within another month. The front section of the school of design building, including the auditorium, the exhibition rooms and the sculpture work on the exterior, is also still under construction. The following new appointments to the faculty of the school of applied science were made this year: Thomas G. Estep, instructor in mechanical engineering; Charles R. Fettke, instructor in geology; S. Leslie Miller, instructor in civil engineering; Andrew S. Yount, instructor in physical chemistry; Charles P. Mills, instructor in mathematics, and Donald H. Sweet, instructor in physics laboratory.

THE trustees of Barnard College, Columbia University, announce that Mrs. Clinton Ogilvie has promised to contribute $10,000 toward $1,000,000 now being raised for endowment.

FOUR thousand dollars to the Massachusetts Institute of Technology for a scholarship preferably to aid Jewish students is a bequest of the late Louis Weissbein, the Boston architect.

THE late Dr. Gavin Paterson Tennent, of Glasgow, by his will bequeathed his entire fortune in medical charity. To the University of Glasgow he left £25,000, as endowment for the faculty of medicine.

THE committee in charge of the Sarah Berliner Research Fellowship for Women offers annually a fellowship of the value of one thousand dollars, available for study and research in physics, chemistry or biology, in either America or Europe. This fellowship is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research; applications for this fellowship must be in the hands of the chairman of the committee, Mrs. Christine Ladd-Franklin, 527 Cathedral Parkway, New York, by the first of January of each year.

PROFESSOR ERNEST MERRITT, of Cornell University, has resigned as dean of the graduate school, the resignation to take effect in June, 1914. Professor Merritt will remain at Cornell, and will devote all his time hereafter to the work of the department of physics.

THE following promotions have been made in the College of the City of New York: Frederick G. Reynolds to associate professor of mathematics. To be assistant professor: R. Stevenson in chemistry; M. Philip in mathematics; A. J. Goldfarb and G. G. Scott in natural history. To be instructor: G. M. Brett in mathematics; F. Woll in physical instruction.

THE following appointments have been made in the school of medicine, University of Pittsburgh: Dr. J. A. Hagemann, instructor in laryngology; Dr. F. V. Lichtenfels, demonstrator in laryngology; Dr. August Soffel, instructor in laryngology; Dr. A. P. D'zmura, demonstrator in medicine; Dr. G. C. Weil, demonstrator in surgery; Dr. E. W. zur Horst, demonstrator in medicine; Dr. A. W. Duff, demonstrator in otology; Dr. H. H. Permar, demonstrator in pathology; Mr. H. N. Malone, student assistant in anatomy. Dr. Ellen J. Patterson has been promoted from assistant professor of laryngology to associate professor.

DR. H. M. SHEFFER, recently instructor in mathematics in Cornell University, has been appointed instructor in philosophy in the University of Minnesota.

DR. GWILYM OWEN, lecturer on physics at Liverpool University, has been appointed professor of physics at Auckland University College, New Zealand.

Professor Roemer, of Marburg, has been called to Greifswald to conduct the hygienic institute as the successor of Professor Loeffler.

DISCUSSION AND CORRESPONDENCE

A NEW TYPE OF BACTERIAL DISEASE

By this title I mean a disease in which the bacterial growth first develops conspicuously as a thick layer on the surface of the plant, and only later penetrates into its interior.

Ráthay's disease of orchard grass (*Dactylis glomerata*) described by him in 1899 may be taken as the type of this kind of disease. In 1913 I had opportunity to verify Ráthay's statements[1] on material sent to me from Denmark by Professor Kϕlpin Ravn, and to make pure cultures and further studies of the organism which in honor of Ráthay, may be known as *Aplanobacter ráthayi* n. sp., with the characters assigned to it by Ráthay, and in addition the following:

Nitrates are not reduced; gelatin is finally liquefied, but liquefaction is visible only after some weeks and progresses very slowly; it does not grow in Cohn's solution; growth starts off slowly in milk, but is prolonged with formation of a copious chrome yellow precipitate and a wide bright yellow rim; litmus milk is first slowly blued, but becomes purplish after some weeks; it grows so slowly on agar that poured plates which appear to be sterile may eventually give small yellow colonies. Nearly all of Ráthay's statements have been found to be correct. This note is here published because of delay in the issue of a longer account.

Erwin F. Smith

THE MANUS OF TRACHODONT DINOSAURS

In a recent article in *The Ottawa Naturalist*,[1] Mr. Lawrence M. Lambe has described "The Manus in a Specimen of *Trachodon* from the Edmonton of Alberta," illustrated by three figures. According to Mr. Lambe's interpretation of the Ottawa skeleton the phalangeal formula is as follows:

Digit II. with three phalanges, the third bearing a hoof.
Digit III. with three phalanges, the third bearing a hoof.
Digit IV. with two phalanges, the second bearing a hoof.
Digit V. with two phalanges, the second bearing a hoof.

Whereas in a specimen that I have described the formula is

Digit II. with three phalanges, the third bearing a hoof.
Digit III. with three phalanges, the third bearing a hoof.
Digit IV. with three phalanges, the third a vestigial bone without hoof.
Digit V. with three phalanges, the third a vestigial bone without hoof.

The writer published a description of the manus of *Trachodon annectens*,[2] based on the first reported specimen in which all of the phalanges are present. In this specimen the full number of phalanges are not only present but each digit is articulated either in the right or the left hand and all are encased in a thin layer of matrix in which the skin impression is preserved.

In this uncrushed specimen the long slender metacarpals of digits II., III., and IV. are closely appressed as represented in the figure accompanying the above article, a position verified by structure and by position in three other uncrushed specimens in the American Museum, one in the National Museum, and a sixth in the collection of the Calgary Natural History Society.

In no specimen of the genus *Trachodon* known to me have more than two hoof bones been found in the manus—those of digits II. and III. The terminal phalanges of digits IV. and V. are, when uncrushed, rounded bony nodules, very much reduced and were not covered by a hoof or nail.

If Mr. Lambe's interpretation is correct we have a remarkable specific variation in this genus in which a later species, described by me, has developed an additional phalanx on each

[1] *Sitz. Ber. Wiener Akad.*, 1 Abt., Bd. CVIII., p. 597.

[1] Vol. XXVII., pp. 21–25, 1913.

[2] *Bull. Am. Mus. Nat. Hist.*, Vol. XXXI., Art. X., pp. 105–107, 1912.

of the two degenerate digits. But I think the evidence is not sufficiently conclusive to warrant his interpretation. The skeleton which I have examined is more than two thirds complete, much crushed, and but few of the phalanges are articulated. It seems quite possible to interpret the phalangeal formula in conformity with other Trachodont skeletons in which the phalanges, being not only fully articulated but enclosed within the web of the skin, are not open to any possibility of error.

In Plate II. showing what Mr. Lambe considers the natural position of the elements the terminal hoof of IV. is evidently II.^{3} and V.^{2} is not a terminal as I have determined by examination.

BARNUM BROWN
AMERICAN MUSEUM OF NATURAL HISTORY
November 20, 1913

AGRO-DOGMATOLOGY

IN SCIENCE of October 3, 1913, there appears under the title "The Bread Supply" a veritable vegetable cell containing a *nucleus* in the form of a quotation from an address by Professor Bolley; some *cytoplasm* of somewhat alkaline reaction provided by Professor Hopkins; *chromatophores* for which various experiments are called upon to furnish local color; *metaplasm* containing a conglomeration of non-essentials, incidentals and chemical dogma; scarcely enough juice to fill even a small *tonoplast;* an impermeable *ectoplasm*—the whole cell suffering from extreme plasmolysis resulting from the toxic fumes arising from very decadent notions of "plant food."

Professor Hopkins refers with "deep respect" to "the science of biochemistry, as the chief means of making plant food available." With such a conception of its nature it would be better to refer to biochemistry with reverence—an attitude of mind often assumed towards the unknown. The biochemist and plant physiologist might well say to Professor Hopkins, as did the Lord to Moses, "Put off thy shoes from off thy feet, for the place whereon thou standest is holy ground."

We are told that Jensen devised a method for "the destruction of fungous diseases sometimes carried in seed grain." I do recall that Professor Jensen developed the so-called "hot water" method for the destruction of the spores of certain fungi known to cause diseases of certain cereals. When such simple facts regarding plant pathology are available in even our elementary text-books it is evident that "no state in the union can afford . . . to have the minds of its farmers and land owners befogged in relation thereto."

In making analyses of commercial fertilizers, soils, ores and similar materials the "analytical chemist" still plays an important rôle; he may even assist in prolonging human life by detecting sodium benzoate in our canned tomatoes, but no one seriously expects him to fully comprehend, even "two or three centuries after its discovery," the relation of the plant to its environment. In "belittling" the work of the analytical chemist in this connection even a hundred columns of words are not so effective as a comparison with the actual achievements of the biochemist and the plant physiologist.

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SCIENTIFIC BOOKS

Nervous and Mental Disease Monograph Series. Edited by DRS. SMITH ELY JELLIFFE and WM. A. WHITE. Published by the Journal of Nervous and Mental Disease Publishing Company, New York.

This series, it is announced, "will consist of short monographs, translations and minor text-books." To judge by the rapidity with which the successive numbers have appeared and by the promptness with which the editions have become exhausted, the undertaking is certainly well conceived. The first 15 numbers include White's excellent "Outlines of Psychiatry," a condensed text-book of 300 pages; "Mental Mechanisms" by the same author; Franz's "Handbook of Mental Examination Methods," and two other original papers, the remaining numbers being translations. Of these, one of the most important is Kraepelin's study of "General Paresis." There are

several translations of works of the "psychoanalytic school," including Freud's "Selected Papers on Hysteria and Other Psychoneuroses" and "Three Contributions to Sexual Theory." The editors of the series, being themselves interested in this movement, are helping to make the psychoanalytic authors accessible in English. As the limits of this review evidently do not admit of an analysis of the whole series of papers, we may confine ourselves to a few remarks on Freud and his school. The two numbers translated from Freud perhaps give as good an insight into the core of his doctrine as could be had in small compass. It is, however, characteristic of this author that cross references are very important in getting his meaning. Everywhere there are gaps in the argument that need to be supplied from some other paper or book; in fact, a reading of all Freud's works still leaves the impression of unbridged gaps, jumps in the thought and incompleteness of evidence. Quite possibly, these deficiencies are inherent in the doctrine at its best, but it is at least to be hoped that some Freudian with a taste for orderly exposition should show what can be done towards giving this fascinating theory a scientific dress.

The whole scope of the Freudian doctrines is very far-reaching, involving a treatment of hysteria and other psychoneuroses, a theory of the mechanism of these disorders, certain significant views on normal as well as pathological mentality, and even certain strictures on the ethics of civilized society. In his psychology, Freud lays stress on the importance of repressed desires, and on the devices by which these desires, though relegated to the "subconscious," yet contrive to express themselves in dreams (every dream being a dramatized or symbolic fulfilment of a repressed wish), in witticisms, and in slips of memory and similar lapses. He is fond of insisting that lapses and apparent irrelevances and extravagances of thought or action do not occur without a cause—by which he means that they do not occur without an emotional and volitional cause. We forget a name because, subconsciously, we wish to forget it, we make a slip of the tongue because some subconscious wish expresses itself in this way, we indulge in witticisms because by them we can give expression to wishes which social custom forbids us to express directly, or which we even do not acknowledge to ourselves. Now society is specially insistent on the repression of sexual wishes; and for this reason, and because sex is a dominant factor in human make-up and because man is driven to "sexualize everything," the repressed wishes which express themselves in dreams and lapses are chiefly and fundamentally of a sexual nature. Furthermore, the repression of sex motives begins early in childhood, for the child is not the sexless creature that he is often supposed to be, but is, on the contrary, strongly sexed from the very start. In part, his sexual proclivities are self-centered and do not drive him to persons of the opposite sex—an infantile condition which persists in some individuals in the form of sexual perversions—but in part, the polarity of the sexes appears already in the young child, so that the boy is sexually attracted to the mother and becomes in his own mind a rival of the father. These sexual proclivities, being socially repressed from a very early age, generate submerged emotional "complexes" which persist from childhood to adult life and form the deepest stratum of that subconscious life of desire which finds expression in dreams, etc. Thus the full analysis of a dream or lapse leads to a suppressed wish, to a sex motive, and ultimately back to the sexual life of childhood. Suppression, sex and infantilism are the three fundamentals of the Freudian psychology.

This psychology is readily applied to the explanation of hysteria, or rather it grew out of a study of hysteria. The "attacks" and other abnormal behavior of hysterics are, like dreams, the expression of repressed sexual wishes dating back to childhood. Often some shocking or disappointing experience of a sexual nature has been repressed from memory, but its "affect" or emotion remains and

invents some substitute for the suppressed memories, thus giving rise to the tics, paralyses, pains, anesthesias and amnesias which continually torment the patient, while occasionally the repressed memories, bursting through the barriers of suppression, take control of consciousness and produce the "attack."

The treatment of hysteria is, accordingly, to discover the suppressed memories and wishes, and satisfy them by "abreaction." The wish must be dealt with in the full light of consciousness. The reaction to it need not be the direct accomplishment of the wish in its original form, but may be "sublimated." The reaction may consist in the quasi-sexual relation between the (usually female) patient and the psychoanalyst, a relation carefully guarded and yet perfectly frank, in which sexual wishes are openly acknowledged and the memories connected with them are ferreted out and rehearsed at length. It is to the method adopted for ferreting out the repressed wishes and memories that the term "psychoanalysis" is most directly applied. The plan is to remove the repression as far as possible, and let the patient's thoughts move freely, in the hope that they will move towards what is repressed. Often a dream of the patient is taken as the starting point, and he is asked to let his thoughts play freely about the items of the dream. This free play of thoughts is called "free association"; but since association is seldom, if ever, perfectly free, the process needs to be examined a little more closely in order to find out what "control" is exerted upon association. The subject is encouraged to look for something emotionally significant and for something which he is tempted to repress; eventually, his thoughts are steered in a sexual direction. The operator, convinced beforehand that this is the direction in which fruitful results are to be found, more or less overtly steers the patient's thoughts. This analysis of the patient's subconscious wishes and memories is a time-consuming process, and of late there is an increasing tendency to take short-cuts by the use of dream symbolism. It appears that certain objects dreamed about, gardens, snakes, stairs and a host of others, are fixed sexual symbols, and, being so interpreted by the operator, enable him to make rapid strides at the beginning of his analysis.

The above inadequate account of Freud's teaching scarcely affords a basis for appraising its scientific or practical value. At the present time, the data are simply not at hand for such an appraisal. Current discussion of the doctrine has not yet reached the level of scientific consideration. The opposition has been characterized by derision and indignation, and the counter-argumentation of the Freudians by repartee rather than by evidence. From the Freudian point of view, opposition is to be expected because men are unwilling to admit their own repressed complexes and the extent to which their lives are dominated by sex. This indicates the manner in which Freudians handle their opponents, and it is certainly not a manner calculated to lead to dispassionate consideration. The result is that there is not a point in the whole Freudian system which can be regarded as either proved or disproved. The evidence as presented by the Freudians is too full of jumps and gaps to be logically convincing, and it would seem that those who embrace the doctrine—as several eminent neurological practitioners, especially in this country, have embraced it—have been not so much convinced as converted—that they have adopted Freudism as a faith, finding it justified by its works, and desiring themselves to practise these works. In other words, they have found the *treatment* efficacious; and the principal argument in favor of the doctrine has been the success of the treatment. (It should be said that there are decidedly two opinions regarding the value of the treatment, and the present reviewer is in no position to pass judgment in this matter.) The weakness of this argument is that it would prove the truth of many rival systems—animal magnetism, Christian Science, "new thought," divine healing, Yoga, osteopathy—each of which meets with appreciable success in treating hysterical and other neurotic cases. Consid-

ered as a scientific hypothesis, the doctrine of Freud suffers from the disability that it apparently can not be put to a crucial test; for whichever way the test came out, the Freudian would find in the result a confirmation of his views. For example, a dream is always the expression of a repressed wish; but if a particular dream that is brought forward seems not to be the expression of a wish, it can be regarded as expressing the wish that the Freudian doctrine be not confirmed, or as expressing a subtle and subconscious opposition of the patient to the operator. Or, again, the open expression of sexual interests by a young child is clear evidence in favor of "infantile sexuality," while the absence of such expression is an evidence of "repression." It is somewhat disconcerting to find that what is ostensibly a psychological hypothesis, to be tested, is in reality a faith to be embraced or rejected.

The sociological implications of the Freudian conception are obvious. Nervous disturbances and much minor mental inefficiency, being due to the repression of sexual motives which is enjoined by civilization, point the way to a reform of society in the direction of greater tolerance and freedom for sexual impulses.

Even anthropology is invaded by the psychoanalysts. Myth and folklore are regarded by them as phenomena analogous in the race to the dreams of an individual, and as expressing in symbolic form the repressed wishes of the race and especially of the childhood of the race. All myths are therefore fundamentally sexual. This line of interpretation, originated by Freud himself, is represented in the present series by Abraham's paper on "Dreams and Myths," which considers especially the story of Prometheus, and endeavors to show that in its earliest form it had distinctly a sexual meaning, later overlaid by more "refined" interpretations. The fire of Prometheus is a sex symbol. Abraham's treatment has one or two obvious weaknesses. He fails to show that repression of sex matters was so strong in the childhood of the race as to create a need for symbolic expression—for it must be remembered that the symbol, according to Freud, comes into play when direct expression is not allowed by the personal or social "censor." This censorship is usually regarded as a characteristic—and defect—of civilization, and why then should it be carried away back to the origin of myths? Even grant the dictum, probably exaggerated, that "man sexualizes everything," we need not conclude that the sex motive is always repressed, to reappear in symbolic form. Fully as plausible would be an exactly opposite, though still sexual, theory of myths, namely, that primitive man, being familiar with reproduction, used it as a symbol or paradigm for interpreting other natural phenomena, so that the sex idea, instead of requiring indirect expression in terms of fire, etc., itself furnished the means for expressing primitive ideas regarding these other phenomena. When, for example, the early Greeks inquired regarding the "physis" or generation of the world, they were using reproduction as a basis for conceiving world processes. Other phenomena were not employed as symbols for sex, but sex was used as a symbol for other phenomena.

If all these ramifications of the psychoanalytic views were modestly put forward as tentative hypotheses, they would awaken interest; and if they were thoroughly worked out and made as precise and systematic as possible, they would deserve serious consideration; but, as a matter of fact, they are presented at once with characteristic sketchiness and cock-sureness. It is a little surprising to find practical physicians interesting themselves in myths and fairy tales. Their reason is thus stated in the preliminary announcement of *The Psychoanalytic Review: A Journal Devoted to an Understanding of Human Conduct,* edited, like the Monograph Series here under review, by Drs. White and Jelliffe and published also by *The Journal of Nervous and Mental Disease,* the first number bearing date of October, 1913: "Briefly stated, the hypothesis which attempts to fathom the laws governing human conduct is the principle that has already done service in the field of biology. It is the recapitulation hypothesis that ontog-

eny is a condensed phylogeny. . . . The mind as it is to-day, like the body as it is to-day, can only be adequately understood in the light of its developmental history throughout the ages of the past. . . . The fields of comparative theology and comparative mythology, of folklore and fairy tales, are rich in material of very practical significance in our present-day problems. . . . Mental disease in its destructive results brings the individual back to primitive and archaic methods of reaction,—reactions which may be better understood when we have studied the mind of primitive man and seen there what they mean." It is certainly satisfactory to psychologists and anthropologists to find their subjects thus enlisting the interest and cooperation of a large body of physicians, and the only apprehension is that the psychoanalytic method, applied in the armchair to the records of primitive man, may appear to the working anthropologist as somewhat lacking in directness and thoroughness.

R. S. WOODWORTH
COLUMBIA UNIVERSITY

The Venom of Heloderma. By LEO LOEB.

Few portions of the world where reptiles occur at all are without some species of serpent venomous enough to be dangerous to human beings. The nature and mode of action of the poison of various serpents has, therefore, been of much practical interest and has attracted the serious attention of investigators in many lands. Nearly all lizards, on the contrary, are harmless. Indeed, the only species known to be venomous are the two kinds of Gila monsters found in Mexico and on our own southwestern deserts of New Mexico, Arizona and Nevada. Perhaps because of its more purely scientific interest, the venom of these lizards has received comparatively little study. The only careful investigations have been by Mitchell and Reichert, Santesson, Van Denburgh and Wight. While these authors have agreed as to the deadly nature of the venom of these lizards they have differed in many points as regards its mode of action.

In a paper of some two hundred and forty-four pages issued by the Carnegie Institution of Washington[1] one finds a series of articles in which are set forth the results of investigations of the poison glands and venom of the poisonous lizards of the genus *Heloderma*. These articles are by Leo Loeb and a large number of collaborators who made use of the Laboratory of Experimental Pathology of the University of Pennsylvania.

The anatomy and histology of the poison glands are described and it is stated that *Heloderma horridum* has the same anatomical arrangement as has been described in the case of *H. suspectum*. It is shown that pilocarpine increases the flow of venom and that transplanted portions of the gland retain their toxic character. Venom was not found in the blood or organs of *Heloderma*, except in the poison glands. It would thus appear that the venom is formed in these glands, not selected and excreted by them, and that there is no internal secretion of venom.

Gila monster venom affects mainly the central nervous system, and death is mainly due to paralysis of the respiratory center. There is a marked primary fall in blood-pressure of vasomotor origin. Diminution in the flow of urine is merely the result of the decrease in blood-pressure. Structural changes in the tissues of the poisoned animal are very slight, but extravasations of blood sometimes occur.

Gila monster venom is stated to cause hemolysis only in the presence of some activator such as lecithin and certain blood sera. It has no cytolytic power except upon the erythrocytes.

Heloderma is immune to its own venom. That is not due to the presence of antitoxin in its circulation.

Dr. Alsberg "succeeded in obtaining the *Heloderma* venom in a state in which it no longer gave the biuret reaction, thus proving

[1] "The Venom of *Heloderma*," by Leo Loeb, with the collaboration of Carl L. Alsberg, Elizabeth Cook, Ellen P. Corson White, Moyer S. Fleisher, Henry Fox, T. S. Githens, Samuel Leopold, M. K. Meyers, M. E. Rehfuss, D. Rivas and Lucius Tuttle, Washington, D. C., May 10, 1913.

that its poisonous principle is a substance free from proteid or only secondarily combined with it."

No local effects were observed at the point of injection of Gila monster venom, and no curare-like action was noted. No marked changes in the clotting time of the blood of animals under the influence of *Heloderma* poison were found.

These studies confirm, in the main, the investigations of Van Denburgh and Wight. Perhaps the principal difference in the two series of observations is regarding changes in the clotting time of the blood. The present investigators report no observed change in clotting time, while Van Denburgh, in pigeons subjected to *Heloderma* venom, found the blood firmly clotted in the auricles while the heart was still beating, and Van Denburgh and Wight observed that a primary shortening in the clotting-time was often followed by a complete loss of coagulability.

The results set forth in this volume by Leo Loeb and his collaborators constitute a valuable addition to our knowledge of reptile poisons. One can not but feel, however, that these results would be more readily available if given in much less extended form, nor need one be an emotionalist to doubt whether these results justify the experimental injection of venom into "more than 360 warm-blooded animals" in addition to many cold-blooded ones.

John Van Denburgh
San Francisco, Cal.

SPECIAL ARTICLES

ANATOMY AS A MEANS OF DIAGNOSIS OF SPONTANEOUS PLANT HYBRIDS

In the genetical studies, which have assumed so large and justly prominent a position in biological work during the past few years, external characters have been investigated almost exclusively. It has in fact been quite generally assumed that plants which resemble one another externally either belong to the same species or are at best only varieties of the same species. Nevertheless it is true that the geneticist has often found it necessary, in his work, to secure by continued cultivation, "pure lines" of the plants he uses in his breeding investigations.

The intention of the present communication is to indicate that spontaneous hybrids are of extremely common occurrence either identical in appearance with recognized species or varying so slightly and constantly over wide areas from the norm, that they are recognized as merely varietal modifications of recognized species. They can often nevertheless be clearly diagnosed as hybrids by the investigation of their internal anatomy both vegetative and reproductive. The full data of these observations, accompanied by the necessary illustrations, will be published elsewhere.

It will be convenient to consider first the case of identical external structure covering profound differences in internal organization. In the course of anatomical experimental investigations, carried on in the laboratories of plant morphology of Harvard University, on some of the lower amentaceous Dicotyledons, specially directed towards the elucidation of the hitherto unrecognized but highly important relation of wood rays to genetical and phylogenetic sequence, material of *Betula pumila,* from the Arnold Arboretum of Harvard University, diagnosed as such both by the Arnold Arboretum and the Gray Herbarium, showed profound differences in organization from wild material of the same species, secured from widely separated localities in the eastern United States and Canada. Vegetatively the Arnold Arboretum specimens presented striking aggregations of wood rays in segments of the woody cylinder, such as are characteristic of the more primitive birches and alders, and in this respect presented a marked contrast to normal *B. pumila,* where rays of this type can not be said to occur. These peculiarities suggested its hybrid origin and the reproductive structures of the abnormal material were investigated for evidence for or against this hypothesis. Male cones examined early in March showed in the sporogenous regions of the anthers large areas of abortive spore-mother cells. Late in April it

was further observed that even in the case of the functional mother cells, that the tetrads frequently produced but one normal pollen grain, the other three persisting as mere vestiges, attached to the germination pores of the completely formed grains. In normal *B. pumila* abnormalities of this nature were not found. Another interesting feature of the development of the microsporangium in the material from the Arnold Arboretum was the abortion of the mechanical or fibroid layer of the anther wall, which in normally developed spore sacks is responsible for the dehiscence of the anthers. Both these features of the stamens of the specimens under discussion, viz., the abortive pollen and the degenerate anther wall, point unmistakably to their hybrid origin.

Professor Jack has been good enough to supply the history of the plants of *B. pumila,* growing in the Arnold Arboretum. They were derived from seed obtained from plants propagated at the Arboretum from wild seed of the species, secured by Professor Sargent in Vermont. A few of the group of individuals thus obtained were clearly hybrids between *B. pumila* and near growing large trees of *B. lenta.* The peculiarities of ray-structure referred to above, namely the aggregation phenomena, are found in neither *B. pumila* nor *B. lenta,* and are doubtless the result of the increased vigor of heterozygosis, as has been noted by Professor East and others. It appears quite obvious, from the various data described here, that the plants of *B. pumila* at the Arboretum, although resembling that species absolutely in external form, are in reality hybrids, as inferred from their more important anatomical features.

The next illustration of the value of anatomical data in the diagnosis of hybrids is taken from the genus *Equisetum.* The species of this genus known as *E. littorale* has long been recognized in Europe and this continent as a hybrid between *E. arvense* and *E. limosum.* It presents transitional features in its external form and internal anatomy between these two species and moreover is characterized by the production of large numbers of abortive spores, which are generally without the "elaters" attached to normal *Equisetum* spores. The genus *Equisetum* is characterized both in this continent and in Europe by the large number of varieties of its species, which occur spontaneously (these would probably be designated by mutationists of the De Vriesian school as "elementary species"). One of these numerous varieties is here taken as an illustration of the value of anatomy in genetical work. Professor Jeffrey observed in material of *E. variegatum* var. *Jesupi,* gathered on Toronto island, that a large number of the spores were abortive and without elaters. A detailed anatomical investigation of this material and of other specimens, including the type, kindly supplied for this purpose by the Gray Herbarium of Harvard University, showed that not only are the spores largely abortive in *E. variegatum* var. *Jesupi,* but that the sporangium wall is also degenerate, lacking the mechanical or fibrous layer. The aerial and subterranean stem further showed a condition of organization intermediate between that found in *E. hiemale* and *E. variegatum. E. variegatum* var. *Jesupi,* is consequently not to be regarded at all as a variety or "elementary species," but as a clear hybrid, in all probability between *E. hiemale* and *E. variegatum.* The writer hopes later to publish extended observations on a number of the "varieties" of species of *Equisetum.*

In conclusion it may be pointed out that the investigation of the anatomy of recognized or crypthybrids is likely to be of great value from the genetical standpoint and will in all probability lay bare the real foundation in fact of the so-called mutation hypothesis of De Vries.

R. HOLDEN

LABORATORIES OF PLANT MORPHOLOGY,
HARVARD UNIVERSITY

THE OHIO ACADEMY OF SCIENCE

THE twenty-third annual meeting of the Ohio Academy of Science was held at Oberlin College, Oberlin, Ohio, on November 27, 28 and 29, under the presidency of Professor L. B. Walton, of Kenyon College.

The address of the President was delivered Friday afternoon, on the subject "The Evolutionary Control of Organisms, and its Significance"; and on Friday evening Professor Dayton C. Miller, of Case School of Applied Science, gave an illustrated lecture on "Sound."

There was an informal gathering of members in the Park Hotel on Thursday evening, and a reception in the Men's Building Friday evening, following the lecture. At the dinner Friday evening, held in the Park Hotel, the Academy was welcomed by President Henry C. King, of Oberlin College.

The arrangements of the local committee were very complete, and the meeting was in every way a very successful one.

The trustees of the research fund announced a further gift of $250 from Mr. Emerson E. McMillin, of New York City, for the encouragement of the research work of the academy. During the past year grants from the research fund have been paid to Clara G. Mark, Alfred Dachnowski, Charles Brookover, Freda Detmers and Stephen R. Williams.

Thirty-five members were elected, making the total membership of the Academy 239.

Officers for the ensuing year were elected as follows:

President—Professor T. C. Mendenhall, Ravenna.

Vice-presidents—(Zoology) Professor Stephen R. Williams, Miami University, Oxford; (Botany) Professor E. L. Fullmer, Baldwin-Wallace College, Berea; (Geology) Professor N. M. Fenneman, University of Cincinnati, Cincinnati; (Physics) Professor A. D. Cole, Ohio State University, Columbus.

Secretary—Professor Edward L. Rice, Ohio Wesleyan University, Delaware.

Treasurer—Professor J. S. Hine, Ohio State University, Columbus.

Librarian—Professor W. C. Mills, Ohio State University, Columbus.

Executive Committee—Professor Frank Carney, Denison University, Granville, and Professor L. B. Walton, Kenyon College, Gambier, to serve with the president, secretary and treasurer, members *ex-officio*.

Publication Committee—Professor Charles H. Lake, Hamilton, to serve with the hold-over members: Professor J. H. Schaffner, Ohio State University, Columbus, and Professor C. G. Shatzer, Wittenberg College, Springfield.

Trustees of Research Fund—Professor M. M. Metcalf, Oberlin College, Oberlin, to serve with the hold-over members: Professor William R. Lazenby, Ohio State University, Columbus, and Professor Edward L. Rice, Ohio Wesleyan University, Delaware.

The complete program follows:

"Plum Creek as a Glacial Chronometer," by G. Frederick Wright.

"Hybridization, Variability and Size," by L. B. Walton.

"Marengo Cave," by W. N. Speckman.

"A Statistical Study of the Physical Measurements of a Class of Students," by Carl J. West.

"The Effect of the Eruption of Katmi on Vegetation," by Robert F. Griggs.

"The Structure of a Fossil Starfish from the Upper Richmond," by Stephen R. Williams.

"With the International Phytogeographic Excursion in America," by A. Dachnowski.

"Comparison of the Mollusk Faunas of the Palæarctic and Nearctic Provinces," by V. Sterki.

"Flood and Drainage Conditions in Vicinity of Bellevue, Ohio," by George D. Hubbard.

"The Species Concept as Applied to the Genus *Pyrosoma*," by Maynard M. Metcalf.

"Geographic Influences in the History of Milan, Ohio," by C. G. Shatzer.

"The Acclimatization of Trees and Shrubs," by William R. Lazenby.

"The Life History of *Euglena*," by Charles G. Rogers.

"Botanical Observations in Alaska," by Robert F. Griggs.

"Conjugation in *Amœba*," by Ralph E. Hedges.

"Variation in *Scirpus atrovirens* and *S. georgianus*," by F. O. Grover.

"Notes on the Metamorphosis of Two Ascidians," by R. A. Budington.

"The Effect of Variation of Intensity and Duration of Stimuli to Reaction Time," by G. R. Wells.

"Pressure Sensation and the Hair Follicle," by R. H. Stetson.

"Further Notes on Embryonic Skull of *Eumeces*," by Edward L. Rice.

"An Addition to the Odonata of Ohio," by Rees Philpott.

"The Box-Elder Bug, *Leptocoris trivittatus*, in Ohio," by W. J. Kostir.

"An Occurrence of *Atypus milberti* Walck, in Ohio," by Carl J. Drake.

"Remarks on the Distribution of Certain Species of Jassidæ," by Herbert Osborn.

"Observations on the Action of the Heart in Mollusca," by V. Sterki.

"Chromosomes in *Opalina*," by Maynard M. Metcalf.

"The Cerebral Ganglia of an Embryo Salamander, *Plethodon glutinosus*," by W. J. Kostir.

"Report on the Work done with the Mollusk Fauna of Ohio," by V. Sterki.

"Some Additional Records for Ohio Mammals," by James S. Hine.

"Notes on the Cheese Skipper, *Piophila casei*," by Don C. Mote.

"The Distribution and Abundance of Some Animal Parasites of Ohio Live Stock," by Don C. Mote.

"The Ecology of Fishing Point, Pelee Island," by Lynds Jones.

"Migration Phenomena in the Sandusky Region," by Lynds Jones.

"The California Tarweed Industry," by Charles P. Fox.

"A Provisional Arrangement of the Ascomycetes of Ohio," by Bruce Fink.

"The Sprouting of the Two Seeds of a Cocklebur," by John H. Schaffner.

"Additions to the State Flora, presenting Two Species of Isoetaceæ from Portage County," by L. S. Hopkins.

"Notes on a Typical Ohio Woodlot," by William R. Lazenby.

"Ecological Varieties as illustrated by *Salix interior*," by John H. Schaffner.

"Certain Peculiarities of the *Botrychia*," by L. S. Hopkins.

"A New Variety of *Carex tribuloides*, with Notes on the Variability of the Species," by F. O. Grover.

"The Behavior of Some Species on the Edges of their Ranges," by Robert F. Griggs.

"The Catalog of Ohio Vascular Plants," by John H. Schaffner.

"A New Method in Lichen Taxonomy," by Bruce Fink.

"Additional Information on the Ohio Devonian," by C. R. Stauffer.

"Some Geological Features in the Newark and Frazeysburg Quadrangles," by G. F. Lamb.

"The Stratigraphy of the Upper Richmond Beds of the Cincinnati," by W. H. Shideler.

"Metamorphism in the Ordovician System of Giles County, Va.," by E. P. Rothrock.

"Evidence of Basining and Folding during the Eopaleozoic of the Southern Appalachians," by P. H. Cary.

"An Ancient Finger Lake in Ohio with Tilted Shorelines," by George D. Hubbard.

"Unconformity and Basal Conglomerates of the Mississipian Age in the Wooster Quadrangle," by G. F. Lamb.

"Methods of Mapping the Shorelines of Pro-Glacial Lakes," by Frank Carney.

"An Eroded Channel in the Cleveland Formation," by W. G. Burroughs.

"The Transparency of Various Substances for Infra-Red Radiation obtained by Focal Isolation," by Alfred D. Cole.

"Note on the Electrical Conductivity of Glass," by Robert F. Earhart.

"The Villari Reversal Effect in Ferro-Magnetic Substances,' by S. R. Williams.

"On the Longitudinal Thermo-Magnetic Potential Difference," by A. W. Smith.

"The Spectrum of Silicon in the Carbon Arc," by C. D. Coons.

"On the Vibrations of a Lecher System using a Lecher Oscillator," by F. C. Blake and Charles Sheard.

"The Wiedemann Effect in Monel and Nichrome Wires," by H. H. Reighley.

Symposium: The Quantum Theory of Matter and Energy.

I. "The Quantum Theory applied to Black Body Radiation," by E. J. Moore.

II. "The Quantum Theory applied to the Determination of the Specific Heat of Solid Bodies," by Charles Sheard.

III. "The Quantum Theory applied to Photo-electric and Thermionic Emission," by S. J. M. Allen.

IV. Title to be announced, by Clark W. Chamberlain.

V. General Discussion.

DEMONSTRATIONS

Rare Minerals from Rhodesia, by George D. Hubbard.

Alaskan Plants, by Robert F. Griggs.

Specimens illustrating California Tarweed Industry, by Charles P. Fox.

Specimens of Mollusca, by V. Sterki.

Ohio Odonata, by Rees Philpott.

Chromosomes of *Opalina*, by Maynard M. Metcalf.

Herbarium Specimens of *Scirpus* and *Carex*, by F. O. Grover.

Model of Embryonic Skull of *Eumeces*, by Edward L. Rice.

EDWARD L. RICE,
Secretary
OHIO WESLEYAN UNIVERSITY,
DELAWARE, OHIO,
December 3, 1913

THE AMERICAN PHYSICAL SOCIETY

The regular Thanksgiving meeting of the Physical Society was held in Ryerson Physical Laboratory, University of Chicago, on Friday and Saturday, November 28 and 29, 1913. The program was as follows:

Friday Afternoon

"Quantum Theory and Radiation," by C. E. Mendenhall.

"Quantum Theory and Photoelectric Effect," by R. A. Millikan.

"Quantum Theory and Statistical Mechanics," by Max Mason.

"Quantum Theory and Atomic Structure," by Jacob Kunz.

"Quantum Theory and Specific Heats," by A. C. Lunn.

Saturday

"The Relation between Photo-potentials and Frequency," by W. H. Kadesch.

"A Study of Contact P.D.'s between Metal Surfaces Prepared in Vacuo; the Effect of Ultra-violet Light upon these P.D.'s; and the Mutual Relation between Positive Potential and Contact P.D.'s," by Albert E. Henning.

"Anomalous Temperature Effects upon Magnetized Steel," by N. H. Williams.

"Experimental Determination of the Earth's Rigidity," by A. A. Michelson.

"A New Maximum in the Wave-length sensibility Curves of Selenium," by F. C. Brown and L. P. Sieg.

"Evidence of a Diurnally Reversing Convectional Circulation of the Atmosphere Over the Upper Peninsula of Michigan," by Eric R. Miller. (By title.)

"Polarization of Long-wave Infra-red Radiation by Wire Gratings," by A. D. Cole.

"Glow Discharge in a Magnetic Field," by R. F. Earhart.

"A Polarization Spectrophotometer Using the Brace Prism," by Harvey B. Lemon.

"Certain Experiments in Sound Diffraction," by G. W. Stewart and Harold Stiles.

"Effect of Space Charge and Residual Gases on the Thermionic Current in High Vacuum," by Irving Langmuir.

"Arrival Curves with Artificial Long Lines," by Carl Kinsley.

"An Attempt at an Electromagnetic Emission Theory of Light," by Jacob Kunz.

"Theory and Use of the Molecular Gauge," by Saul Dushman.

"A Modified Method of Measuring e/m and v for Cathode Rays," by L. T. Jones.

"An Experimental Determination of the Correction to the Law of Stokes for Falling Bodies, and of the Value of the Elementary Charge e," by John Y. Lee.

"On the Coefficient of Slip Between a Gas and a Liquid or Solid," by R. A. Millikan.

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The American Association for the Advancement of Science and the national scientific societies named below will meet at Atlanta, Ga., during convocation week, beginning on December 29, 1913.

American Association for the Advancement of Science.—President, Professor Edmund B. Wilson, Columbia University; retiring president, Professor Edward C. Pickering, Harvard College Observatory; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor Harry W. Springsteen, Western Reserve University, Cleveland, Ohio; secretary of the council, Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.

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Section C—Chemistry.—Vice-president, Dr. Carl L. Alsberg, Bureau of Chemistry; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. O. P. Hood, U. S. Bureau of Mines; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

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Section I—Social and Economic Science.—Vice-president, Judson G. Wall, Tax Commissioner, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

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Section L—Education.—Vice-president, Dr. Philander P. Claxton, Commissioner of Education, Washington, D. C.; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

The Astronomical and Astrophysical Society of America.—December 29–January 3. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Physical Society.—December 29–January 3. President, Professor B. O. Peirce, Harvard University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 30. President, Professor C. R. Mann, University of Chicago; secretary, Dr. Wm. A. Hedrick, Washington, D. C.

The Entomological Society of America.—December 30–31. President, Dr. C. J. S. Bethune, Ontario Agricultural College; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 31–January 2. President, Professor P. J. Parrott, Geneva, N. Y.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 30–January 2. President, Professor D. H. Campbell, Stanford University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 30–January 2. President, F. C. Stewart, Agricultural Experiment Station, Geneva, N. Y.; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Microscopical Society.—December 30. Secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Association of Official Horticultural Inspectors.—December 29. President, E. L. Worsham, Atlanta, Ga.; secretary, J. G. Saunders, Madison, Wis.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor H. J. Pearce, Gainesville, Ga.; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The Sigma Xi Convention.—December 30. President, Professor J. McKeen Cattell, Columbia University; recording secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

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The American Physiological Society.—December 29–31. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

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The American Folk-Lore Society.—December 31. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

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The Association of American Geographers.—Probably meets at Princeton but official information has not been received.

The Palæontological Society.—December 31–January 1. President, Dr. Charles D. Walcott, Smithsonian Institution; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

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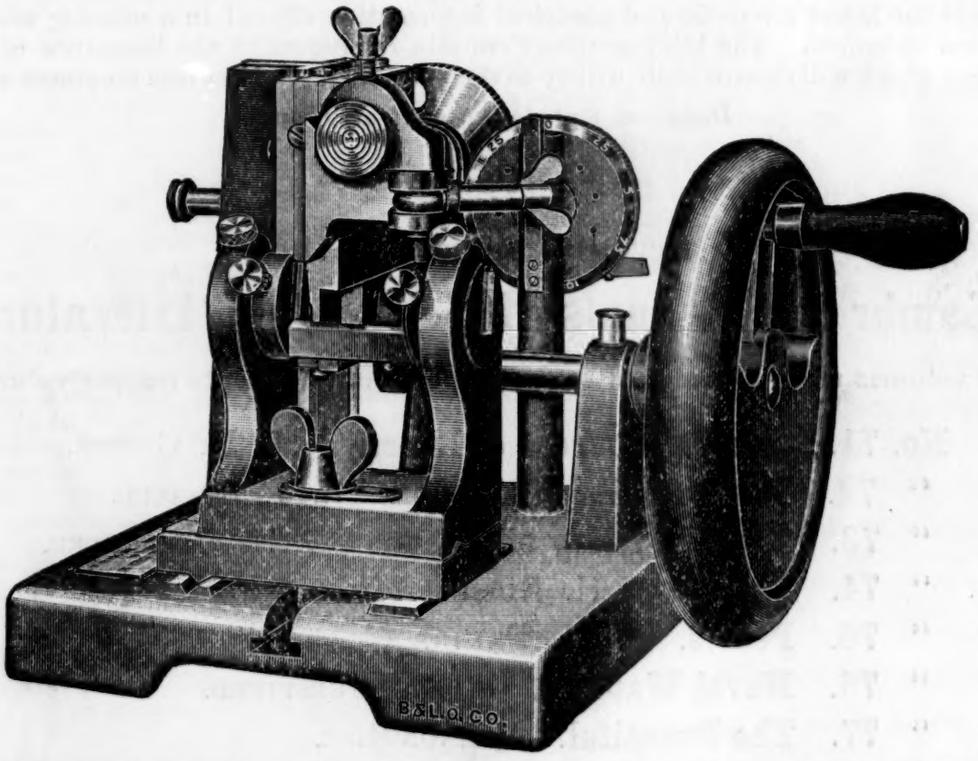

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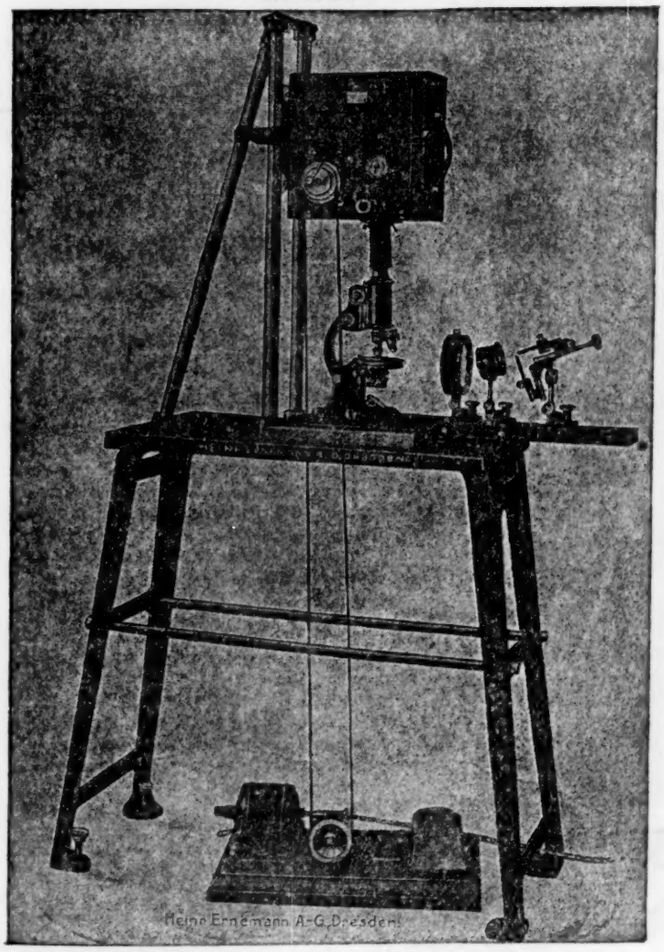

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REQUIREMENTS FOR ADMISSION: Candidates must have successfully completed work equivalent to that prescribed for the Freshman and Sophomore Classes in colleges recognized by this University, which must include collegiate courses in Physics, General Biology or Zoology and Chemistry (Qualitative Analysis is required; Organic Chemistry is recommended), together with appropriate laboratory exercises in each of these subjects, and two languages other than English (one of which must be French or German). For detailed information send for catalogue. Certificates from recognized colleges covering these requirements will be accepted in place of an examination.

UNDERGRADUATE COURSE: The course of instruction extends over four annual sessions, the work so graded that the first and second years are largely occupied by the fundamental medical subjects. The third and fourth years are largely devoted to the practical branches, prominence being given to clinical instruction, and the classes sub-divided into small groups so that the individual students are brought into particularly close and personal relations with the instructors and with the patients, at the bedside and in the operating room. It is strongly recommended that after graduation further hospital work be undertaken by the members of the class; and more than 90 per cent. attain by competitive examination or by appointment positions as internes in hospitals in this city or elsewhere. The Pennsylvania Bureau of Medical Education and Licensure will hereafter require of applicants for license, a year spent in an approved hospital.

POST-GRADUATE WORK: (1) Any graduate possessing a baccalaureate degree may pursue work in Anatomy, Physiology, Physiological-Chemistry, Bacteriology, Pathology, Neuropathology, Pharmacology, Research Medicine and Mental Diseases with view of obtaining the higher degrees of Master of Arts or Science and of Doctor of Philosophy in the Graduate School of the University. For information address Dean of Graduate School, University of Pennsylvania.

(2) Courses in Public Health (inaugurated in 1906), leading to diploma (Doctor of Public Hygiene, Dr. P.H.) are open to graduates in Medicine. The subjects comprehended in the course are: Bacteriology, Medical Protozoology and Entomology, Chemistry, Sanitary Engineering, Sanitary Architecture, Meat and Milk Inspection, School Inspection, Vital Statistics, Sanitary Legislation, and Personal and General Hygiene.

The full course extends over one academic year. Special subjects in the course may be taken by any one possessing suitable preliminary qualifications. For details address Director of Laboratory of Hygiene.

(3) From the opening of each term to about February 1 courses in Tropical Medicine are open to graduates in medicine comprehending instruction in Medical Climatology and Geography, Hygiene of Tropics and of Ships, Tropical Medicine, Bacteriology, Protozoology, Entomology, Helminthology, and General Medical Zoology, Pathology, Skin Diseases, Eye Diseases, and Surgery of Tropical Affections.

(4) During the academic session special courses in any of the branches of the medical curriculum are open to graduates of this or other regular schools of Medicine, both in the clinical subjects and in laboratory studies. The excellent hospital facilities offered by the University Hospital, the neighboring Philadelphia General Hospital and other institutions with which the members of the staff of instruction are connected, guarantee exceptional opportunities for clinical observation

TUITION FEE: Undergraduate study, $200 annually; fees for special courses on application. For detailed information or catalogue address

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Mobile, Alabama

Entrance Requirement.
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For copy of the annual announcement and any desired information, address

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School of Medicine

St. Anthony and Lawrence Sts.,
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Washington University Medical School

REQUIREMENTS FOR ADMISSION

Candidates for entrance are required to have completed at least two full years of college work which must include English, German, and instruction with laboratory work in Physics, Chemistry and Biology.

INSTRUCTION

Instruction begins Thursday, September 25, 1913, and ends Thursday, June 11, 1914.

Clinical instruction is given in the Washington University Hospital, controlled by Washington University, in the Saint Louis Children's Hospital, in the Mullanphy Hospital and in the dispensaries connected with these institutions. During the session of 1913-14 the Medical School will move to its new buildings immediately adjacent to the Barnes Hospital and the St. Louis Children's Hospital which are affiliated with the Medical School.

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The catalogue of the Medical School may be obtained by application to the

Dean of the Washington University Medical School,
1806 Locust Street Saint Louis, Missouri